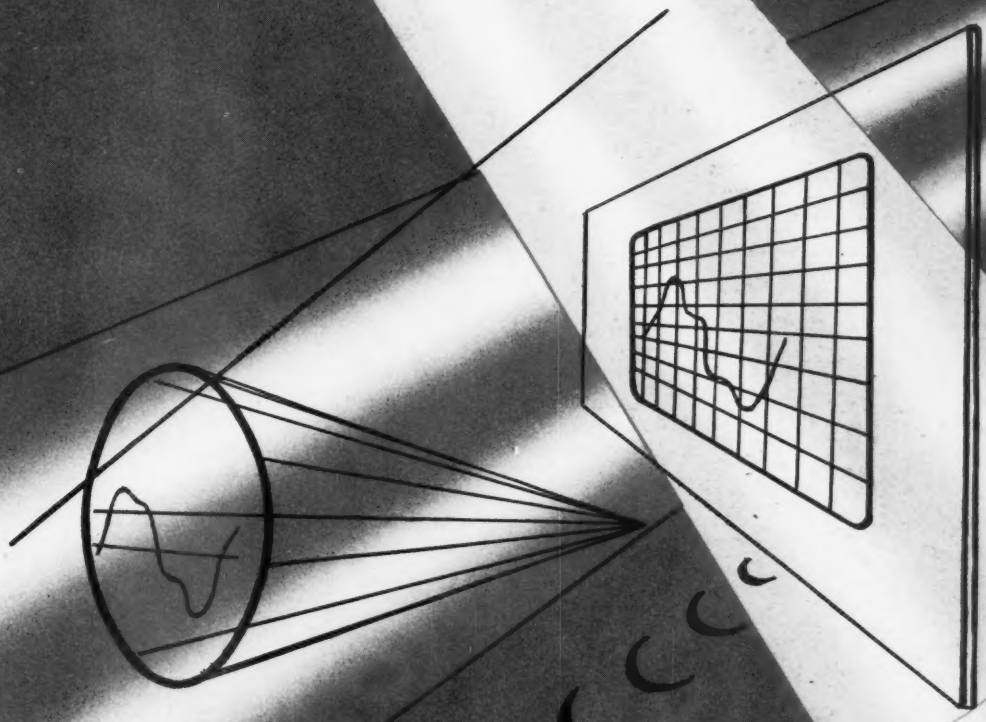
THE TECH ENGINEERING NEWS



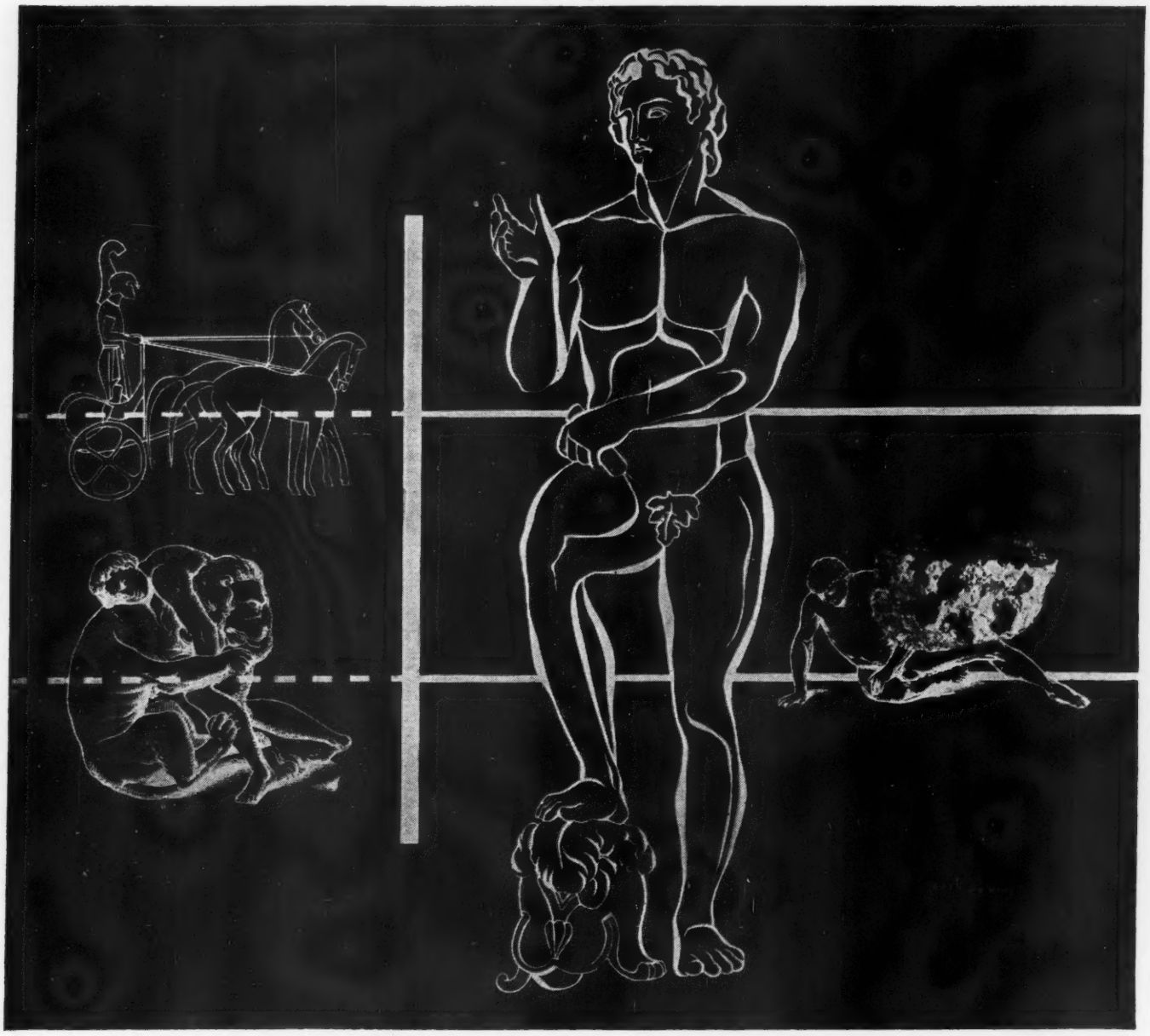
march · 1947

25 cents

IT TAKES MORE THAN MUSCLE

According to legend, Polydamas, the Greek athlete, killed a lion with his bare hands, stopped a chariot in full flight, and lifted a raging bull off the ground with ease. His career, however, came to a spectacular end when he tried to catch a huge falling rock.

Today, sudden, heavy loads end the life of many steel parts. Low temperatures, for instance, can have a depressing effect on the impact strength of steels. Molybdenum steels, which combine deep hardening and freedom from temper brittleness, reduce this risk.



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MOLY

*The "Orukter Amphibolos," a steam-powered, amphibious dredge, built by Oliver Evans in Philadelphia, in 1803, shown emerging from the Schuylkill River.

His genius would have been futile without hard work

The "Orukter Amphibolos"* was more than a curiosity in 1803. An amphibious dredge, it began a new era — the mechanization of contracting industries. Its greatest claim to renown came from its inventor, Oliver Evans. First to design a high pressure steam engine, he built engines for pumping and hoisting, invented the elevator, conveyor, descender and the hopper for flour mills. But his foremost genius was for conscientious work . . . with that he made new industries possible.

American creative genius would have been futile without management ability and honest toil to develop our industries. This nation has become a beacon of hope for the world because sound management and conscientious work have together turned scarcity into abundance. We'll have that abundance in greater measure only if everyone realizes that even machines won't produce without an honest day's work to keep them going.

• • •

If Evans were alive, he would advocate the use of anti-friction bearings in contracting equipment. Made in every size and type that industry needs, SKF *ball and roller bearings are found everywhere in modern, high speed contractor's machines. They helped to make Boulder Dam and other great construction projects possible; and everywhere they prove to be:*

THE RIGHT BEARING FOR THE RIGHT PLACE

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BALL AND ROLLER BEARINGS

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COLUMBIA CHEMICALS

Safeguard Health

Among the varied uses of Pittchlor are important applications for swimming pools—chlorination of water supplies, general sanitation in and around pools, locker and shower facilities.

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Pittchlor is a high-test calcium hypochlorite containing a minimum of 70% available chlorine. Granular in form, it is free-flowing and dust-free and dissolves rapidly in water to make chlorine solutions of the required strength for many uses. The ease of handling, either manually or by comparatively simple feeding devices, makes Pittchlor highly desirable for chlorination of water supplies, for the treatment of sewage, and for many other tasks where the positive disinfection and deodorizing properties of chlorine are needed. It is also widely used by laundries as a precision bleach.

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Here's help in bridging this gap

To help bridge the gap between college and industry, Westinghouse many years ago established its Graduate Student Training Course. This plan has provided practical training for more than 14,000 college graduates in its more than 50 years of operation.

Through basic training in industrial methods and organization, plus practical work assignments to prepare the way for future specialization, the course equips graduates to find their most effective place in the Westinghouse organization.

A new booklet, *Finding Your Place in Industry*, describes this course in detail. It also contains many helpful suggestions on choosing the right job and the right company—regardless of what career you plan to follow.

Get your copy of this helpful book at once. It's free! G-10005

Westinghouse

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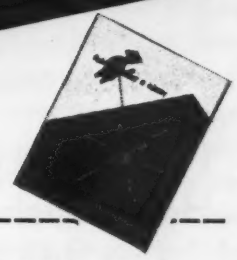

To obtain copy of *Finding Your Place in Industry*, consult Placement Officer of your university, or mail this coupon to:

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Briefing the News . . .

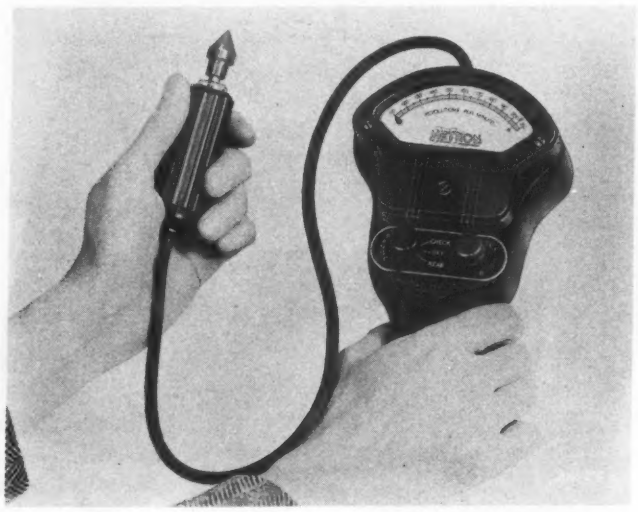
An Artificial Kidney . . .

DR. W. K. HOLFF of Holland has developed an "artificial kidney" which is of enormous value in accidents or diseases in which the kidneys temporarily fail to function. The apparatus consists of one hundred and fifty feet of cellulose tubing immersed in a normal salt solution. Blood from an artery of the patient passes through the tube and returns to a vein in the body. Urea and other poisonous substances normally removed by the kidneys from the bloodstream diffuse through the cellulose membrane into the salt solution, and are thus removed from the body.

The apparatus, which has been demonstrated at Mt. Sinai Hospital, in New York City, has already saved the lives of over a half a dozen persons. It is most useful in cases of lead or mercury poisoning, toxic reactions to sulfa drugs, and reactions to blood transfusions, but it is equally applicable in any case where the kidneys need but a few days to regain their functional power.

Fog-Piercing Lenses for Cars . . .

In place of buying a pair of orange fog lights for his car, a motorist can now purchase a pair of snap-on orange colored lenses for his present sealed-beam headlights. They cost little compared to complete fog lamps, and can easily be put on or taken off.



The Metron Company's New Hand Tachometer

Highly Accurate Hand Tachometer . . .

A new highly accurate tachometer, an instrument for measuring the speed of revolution of motors and shafts, has been built by the Metron Instrument Company. It consists of a tiny electric generator the shaft of which can be pressed against a revolving object. Wire leads from the generator pass to a galvanometer, which directly records the speed of rotation.

The current developed by the generator is directly proportional to its speed of rotation, so that the meter scale is linear. The instrument can be carried in the hand, and is expected to wear out very slowly, because of its freedom from unnecessary revolving parts.

Solar Furnace . . .

At the Observatory of Meudon, France, a solar furnace has been built that can attain a temperature of five thousand degrees centigrade. Graphite has been changed from a solid to a gas in a short time, and masses of iron have been melted and partially vaporized within a few seconds.

The heart of the furnace is a parabolic mirror over two yards in diameter, which brings the sunlight to a focus at a point. Since sunlight contains about a kilowatt (about one and a half horsepower) per square yard, the mirror concentrates about three kilowatts of power at a single point, and thus can create enormous temperatures.

The research workers responsible for the installation of the new mirror are Drs. Foex and Trobme and Mlle. la Blanchetais.

Sound Movies on Metallized Film . . .

A new method for recording sound on film has been devised by Dr. Marvin Kamras, the inventor of the wire recorder. A narrow strip of magnetic material is placed near the edge of a conventional motion picture film, and a small electromagnet connected to a microphone is used to magnetize it as the film unwinds in the camera. The magnetic material passes unaffected through the developing process. · When the film is finally projected on a screen, it passes a small electromagnet in the projection camera. Tiny currents are induced in the magnet in response to the magnetization of the sound track, and these are amplified and played through a loudspeaker.

The magnetic recorder will be a great boon to amateur camera enthusiasts, for it can be attached to a camera and adds very little to its weight. The sound track can later be erased, if desired, by demagnetizing it, and a new sound recording can be made in its place.

The reproducing electromagnet can be attached to any home projector, and a sound track can be impressed on any previously developed film to convert a group of silent films into a complete sound film library.

The Train of Tomorrow Is Here . . .

This summer the Pullman Company is planning to bring a new train incorporating all of the features of a "train of tomorrow" into principal cities of the United States. It will feature triple-deck cars with an *Astra Dome*, or star dome, on top of each car. Consisting of laminated carefully annealed glass, it permits all of the passengers of the upper level to see out in all directions. The glass is heat absorbing and consists of two layers with an insulating airspace in between.

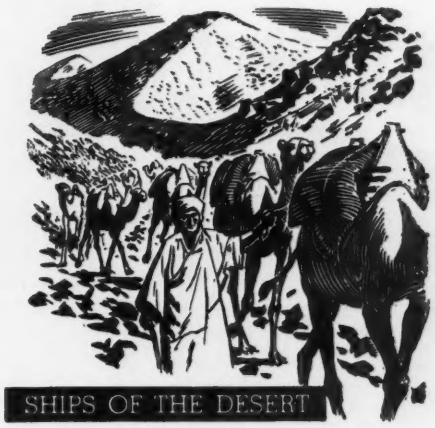
The train will carry telephones, for talking within the train and to the rest of the country through Bell wireless telephone. In stations, ordinary telephone lines can be plugged into the train to connect the train with the local telephone exchange.

The train incorporates many safety features not found in conventional trains. They have a low center of gravity and a suspension system for the coaches which automatically tips them inward on a curve. An automatic signal warns the trainmen of possible "hot boxes" developing during the trip.

THE STORY OF CHROMIUM

COLOR FOR ARTISTS

The yellows, blues, and violets of the artist's palette; the red of the ruby, the green of the emerald — all come from chromium, a metal named from the Greek word *chroma*, meaning color. Discovered in 1797, this metal was for years just a laboratory curiosity, but is now top-ranking among alloys.

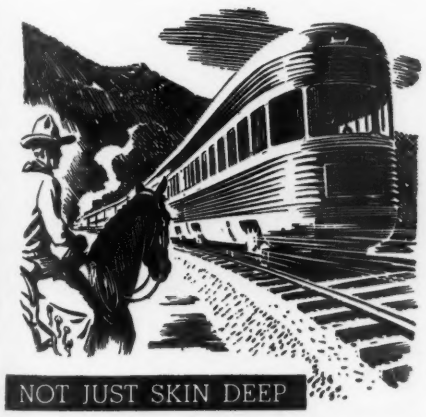


SHIPS OF THE DESERT

Caravans of camels laden with chromite ore have often formed the first link on an assembly line thousands of miles long. From the mines of Rhodesia, Turkey, Russia, and India this valuable ore starts its long journey to Electromet furnaces, where dozens of different types of chromium alloys are produced.

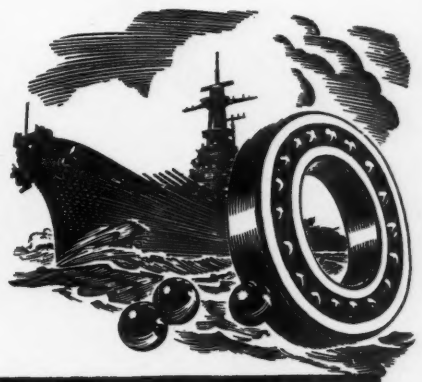
VERSATILE ALLOY

This silvery-white metal, used with steel and iron in amounts from 1 to 35 per cent, imparts many of its own desirable properties. To stainless steels, chromium gives resistance to heat, rust, and corrosion—to heat-treated steels, strength and resistance to shock—to cast iron, hardness and wear resistance.



NOT JUST SKIN DEEP

The luster of stainless steel withstands all weather conditions—on streamlined trains as well as on skyscrapers. For hospital, food, and dairy equipment, too, this steel is popular, since it is so easy to clean and sterilize. And for the oil and chemical industries, its resistance to corrosion and heat makes it ideal.



BEARINGS TO BATTLESHIPS

Axles and armor plate, dies and drills, shafts and springs — these are made from engineering steels that must have the hardness and strength necessary to withstand wear and strain. That's why engineers specify steels with 1 to 3 per cent chromium for applications where dependability is essential.

It's Been A Long Time

...since Electromet started to produce ferro-alloys — 40 years ago. In fact, as far back as 1897, a plant in Virginia, which later joined Electromet, was the first to produce ferrochrome commercially in the United States. Electromet is constantly developing new and better alloys, among them the low-carbon ferrochrome essential in the production of stainless steels. You will learn more about chromium and other alloys by writing to our Technical Service Department for the booklet, "Electromet Products and Service."

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
30 East 42nd Street UCC New York 17, N. Y.

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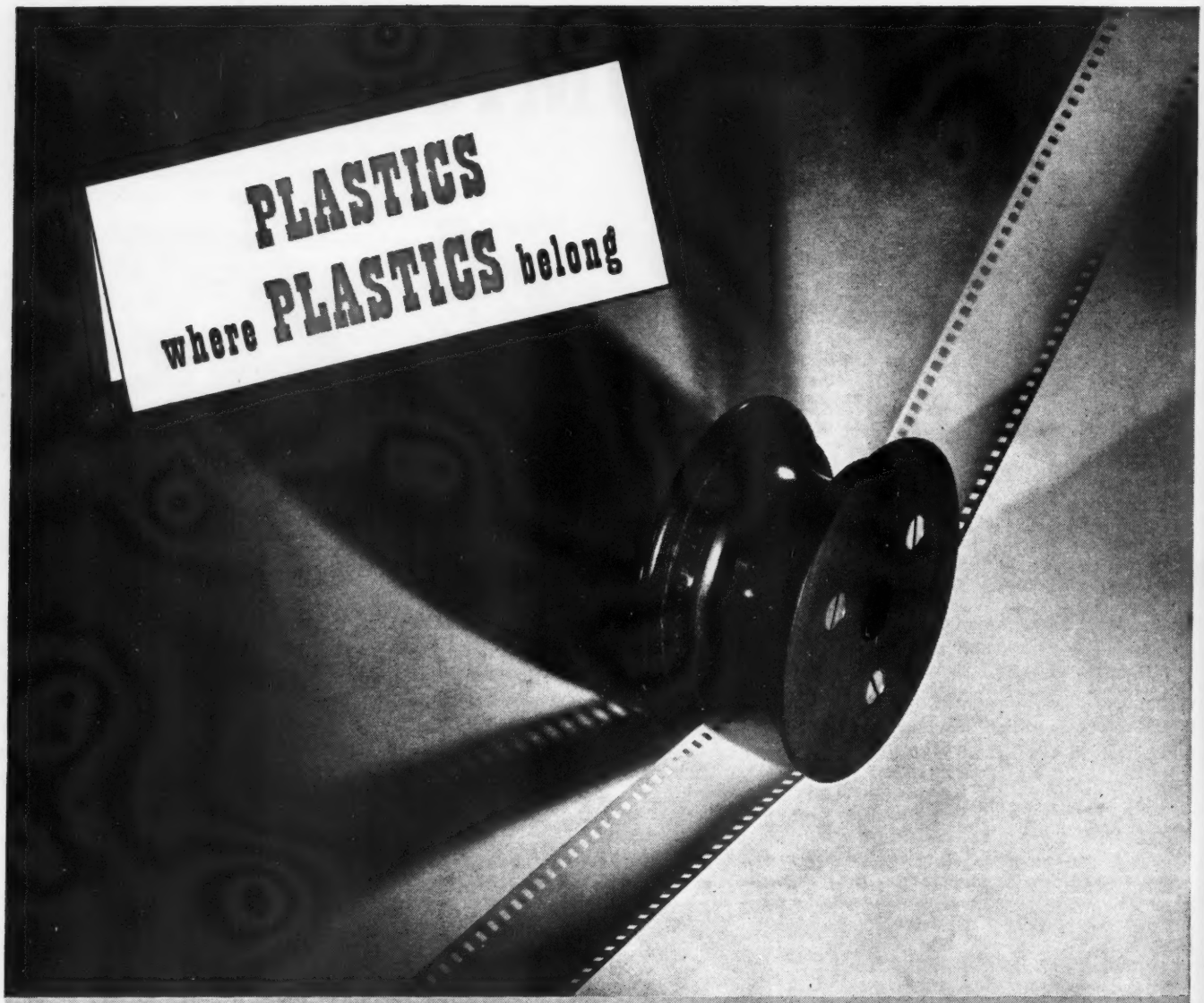

Using Corrosion Resistance, Strength, and Machinability

MOVIE FILM carriers are an excellent example of using plastics where plastics belong.

The film carrier illustrated is only one of many types made from Synthane laminated plastics. Synthane is well-suited for the job because it stoutly resists the corrosive action of developing solutions.

The teeth, though small, must be strong and accurately indexed. They are easily milled from Synthane.

Whenever in your future work you have an application for laminated plastics, let us know about it—*before* you design, if possible.

Synthane's help includes design, selection of the right material, and fabrication by men who know plastics. Synthane Corporation, Oaks, Penna.

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The TECH ENGINEERING NEWS

PROFESSIONAL JOURNAL OF THE UNDERGRADUATES

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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MARCH, 1947

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Design and drawing by Katherine Rogers

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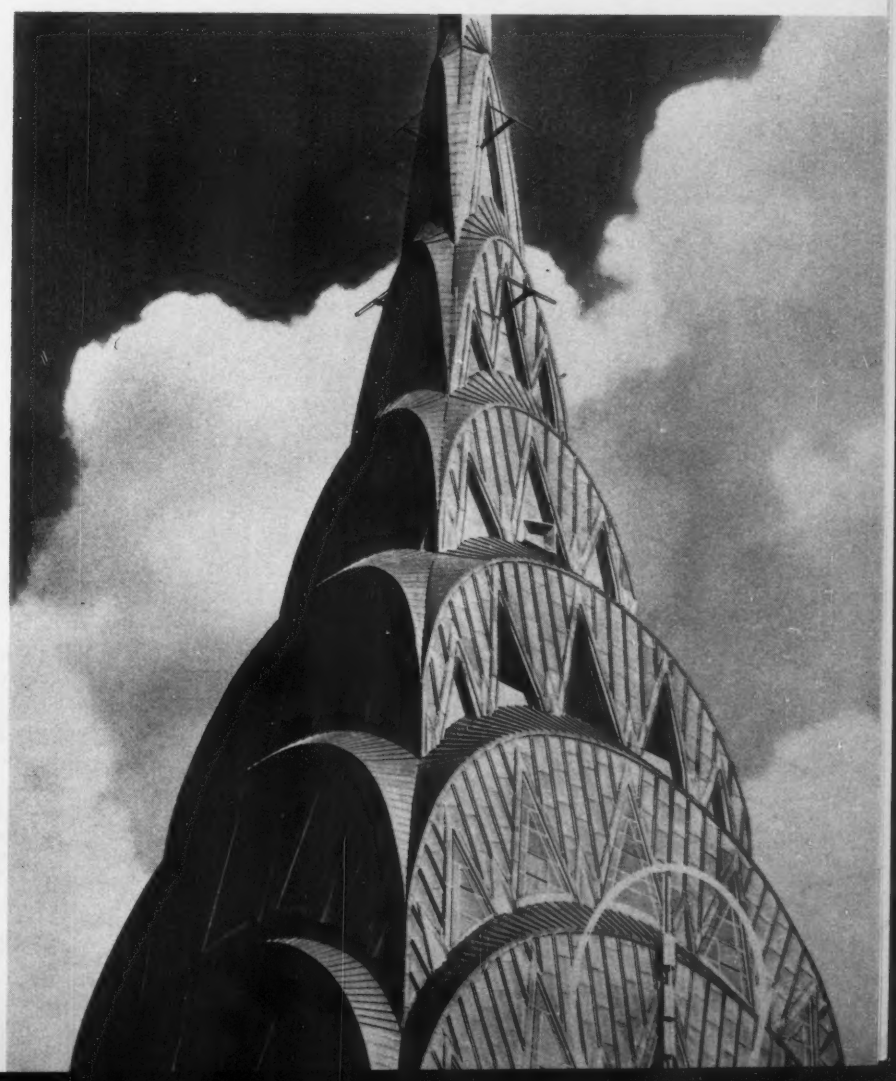
Antenna for transmission of the CBS color-television system located atop the Chrysler Building

Columbia Broadcasting System



MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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A parabolic receiving antenna aimed at the transmitter which broadcasts from the tower of the Chrysler Building in New York City, seen in the background *Columbia Broadcasting System*

Color Television

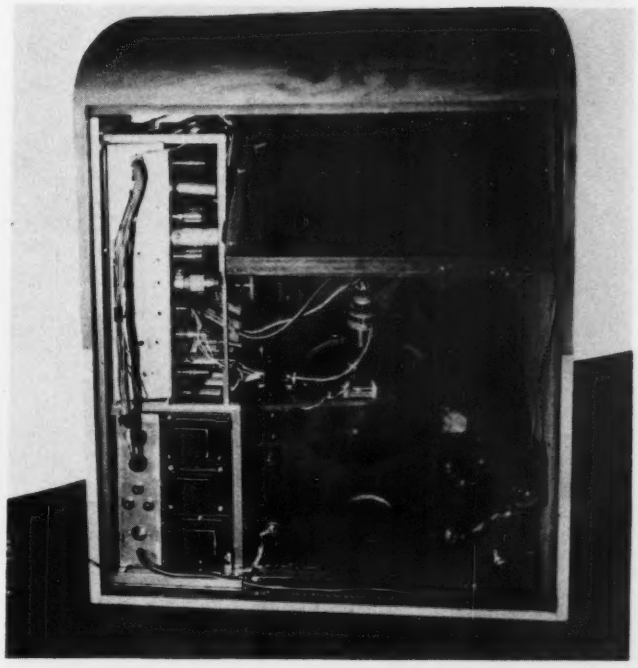
By RICHARD W. SPENCER, '49

TELEVISION on a commercial basis became feasible with the development of the cathode-ray tube. Experimenters in the past have attempted to produce pictures mechanically, but the cathode-ray tube supplied what the mechanical methods lacked — a practical method of producing pictures with sharp definition in rapid enough succession so that, with the help of persistence of vision and the persistence of the phosphor on the tube face, there was no noticeable flicker.

The picture on the face of the television tube is produced by the rapid motion of a luminous spot which varies in intensity and moves in regular lines over the entire area of the picture. In present commercial television, pictures composed of 525 closely spaced horizontal lines are "drawn" by this rapidly moving spot, each complete picture being produced in one-thirtieth of a second. This picture frequency yields satisfactory pictures without flicker.

Monochromatic (black and white) television has been in use commercially for some time. Engineers have long sought ways to reproduce color, as well as intensity, in the picture. It appears that the realization of this on a commercial scale is not far off.

The introduction of color into the picture is accomplished by the additive mixing of three primary colors, usually a red, a blue, and a green. Two important methods of color television are being developed at present. One, known as the sequential method, being pioneered by Columbia Broadcasting System, involves the showing of three different colored pictures on a screen in rapid succession. The other, being developed by the Radio Corporation of America, also uses three colored pictures, but all three are thrown on a screen simultaneously by an optical system. This is called simultaneous projection. Let us examine these methods in more detail.

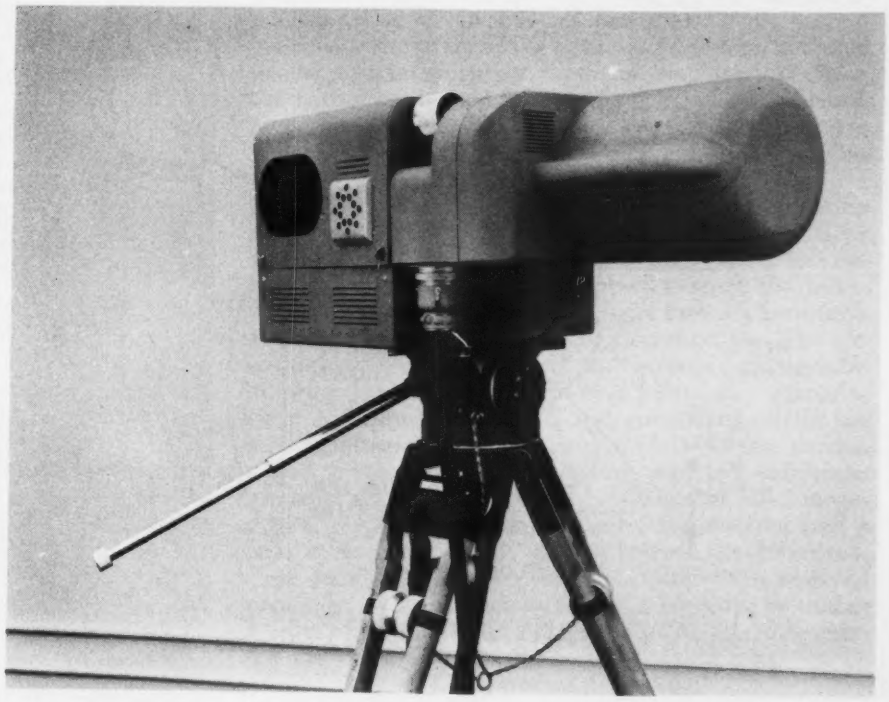


Columbia Broadcasting System

A rear view of the receiving set for color television. The cup-shaped color wheel is shown at the right of the projection tube, above the spherical mirror

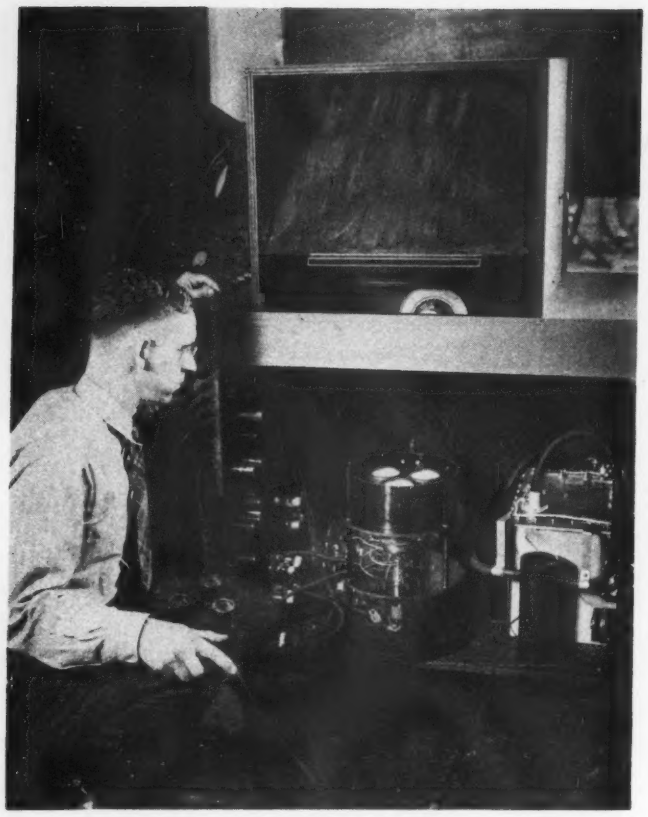
In CBS's sequential system the optical system of the camera includes a rotating disc containing colored filters through which the light beam is made to pass. While any one filter is interposed in the optical system, only the light passed by that filter will be recorded by the camera. When, for example, the red filter is interposed, only those parts of the object which emit light of wavelengths predominantly in the red portion of the spectrum will be recorded.

Three different colors—red, blue, and green — are used in the color wheel, as this disc is called. Its rotation causes the camera to be exposed to a rapid succession of red, blue, and green pictures. The camera records a sequence of monochromatic pictures. For simplicity, imagine one portion of a stationary object being televised to be a bright red, another portion a bright blue, and another a bright green. The picture recorded while the red filter is inter-



The new live pick-up color television camera, using an orthicon tube

Columbia Broadcasting System



A research engineer checks the component parts of a new all-electronic television receiver

Radio Corporation of America

posed would show a white area corresponding to the red area of the object. Similarly, when the blue or green filter is interposed, the picture recorded would show a white area where the object is blue or green. The camera itself, excluding the color wheel and its associated equipment, is monochromatic. It does not distinguish color, but only intensity of light.

The camera in the CBS system does not sweep all 525 lines in order from top to bottom, but rather sweeps the second, fourth, sixth, and so on down through the even-numbered lines, and then returns to the top of the picture and sweeps the odd-numbered lines in order, creating two interlaced fields.

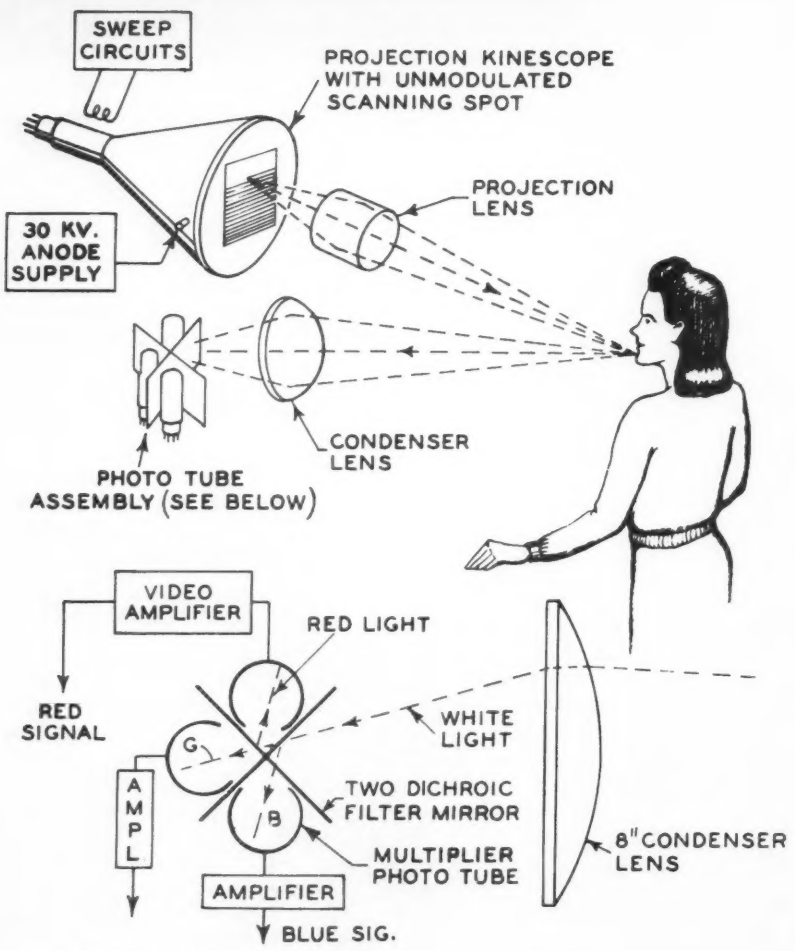
The motor which drives the color wheel is synchronized with the sweep circuit so that during the first pass through the picture (the even-numbered lines) the red filter is interposed. During the next pass (the odd-numbered lines) the blue sector is interposed, and so on through the cycle. The whole cycle of six fields can be represented in tabular form:

262.5 even lines in red
262.5 odd lines in blue
262.5 even lines in green
262.5 odd lines in red
262.5 even lines in blue
262.5 odd lines in green

It is seen that during every complete cycle every line is swept once in each color. The complete cycle takes 1/20 of a second. Each field takes 1/120 of a second. This interlaced field and rapid alternation of color is used to avoid flicker, both that due to change in intensity and that due to change in color.

CBS now operates a color television station, W2XCS, in New York, transmitting at 490 megacycles. Columbia has found that the ultra-high-frequency bands (480–920 mc) have two immediate advantages: (1) More efficient radiation is possible with properly designed antennas because of the shorter wavelengths. A beam width of six degrees in the horizontal plane has been obtained. (2) The high frequency makes possible the use of parabolic receiver antennas of such good directivity that no reflections are visible in the receiver. Furthermore, it is actually possible to obtain perfect pictures from a reflection without interference from the direct signal!

The sound signal in the CBS system is transmitted as pulses of frequency-modulated subcarrier energy having a frequency of about eight megacycles, during the horizontal retrace time of the picture tube, 31,500 pulses occurring in one second, or one after each line scanned. The frequency-modulated eight-megacycle signals are produced by amplitude-modulating the



FLYING SPOT STUDIO PICKUP FOR SIMULTANEOUS COLOR TELEVISION

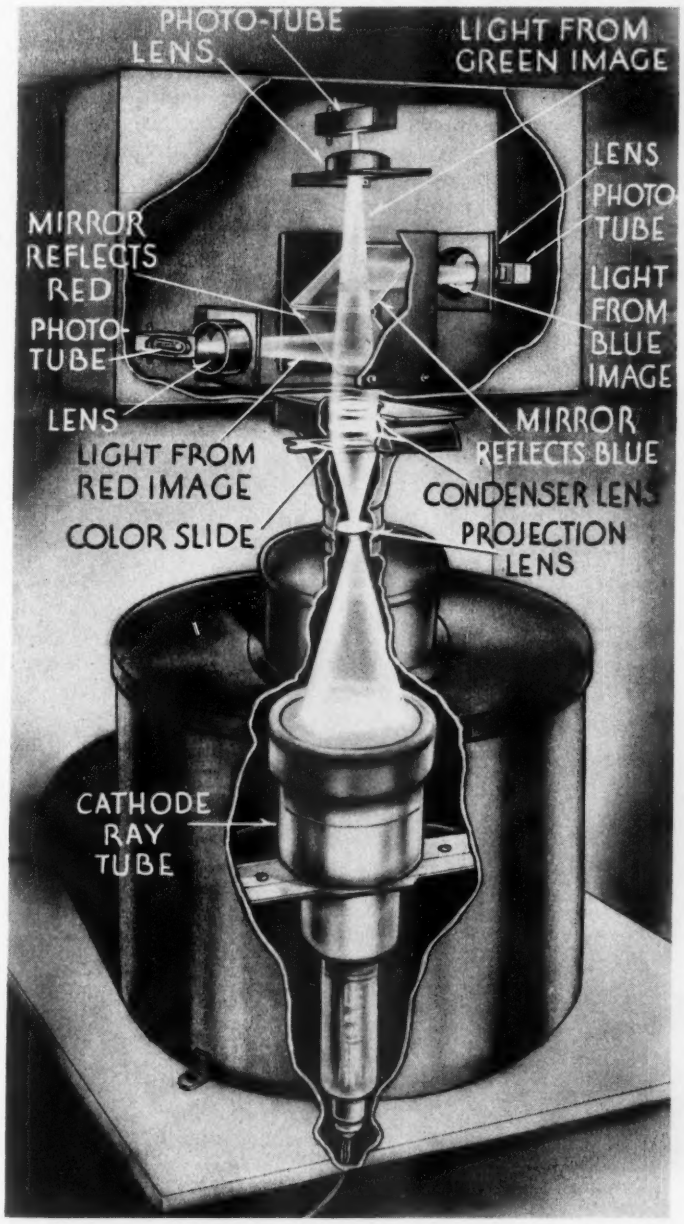
Radio Corporation of America

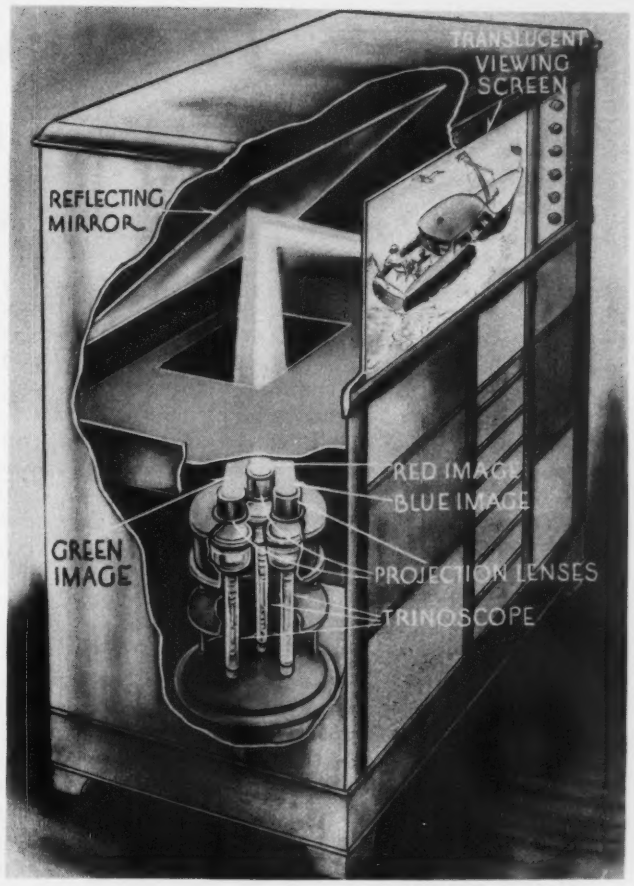
490-megacycles carrier during the picture tube blanking pulse. The sound channel is thus associated with four frequency bands: (1) its own frequencies in the audio band, (2) the pulse frequency of 31,500 cycles per second, (3) the subcarrier frequency of about eight megacycles, and (4) the radio-frequency carrier, about 490 megacycles. Each pulse "samples" the momentary amplitude of the sound frequency. Sounds of frequencies up to about one-half the pulse frequency, or about 15,000 cycles, can be handled satisfactorily in this way.

The FM pulses are separated out at the second detector or at one of the video stages in the receiver. This can be accomplished by utilizing resonance methods at the eight-megacycle frequency and a "shutter" tube which opens the audio channel at the termination of each blanking pulse.

At the all-electronic color camera, the light beam from a cathode-ray tube is projected upward through a Kodachrome slide and through a series of color filters which separate respectively the red, blue, and green portions of the image. Each color is then reflected into photocells which change the light values into electrical signals for transmission to the receiver

Radio Corporation of America





Radio Corporation of America

Diagrammatic sketch of RCA color television receiver showing the method of image blending

The television receiver is similar in many respects to a black-and-white television receiver, but with the addition of a color wheel in the optical system, similar to that used in the camera, and synchronized with the sweep circuit so as to have the proper color filter in position at all times. The colored picture which the observer sees is actually a rapid succession of monochromatic pictures in three different colors, blended by persistence of vision into one picture.

RCA's simultaneous system has been demonstrated, producing pictures from Kodachrome film. As far as the author knows, RCA has not yet televised live studio scenes in color. It has been predicted that such scenes will be televised by the middle of 1947, and outdoor action scenes a few months later.

In the camera for televising colored slides, a scanning cathode-ray tube scans the slide, in white light. The light passing through the slide then encounters two color-sensitive mirrors in the optical system, the first of which reflects most of the red light into a photo-tube, allowing the rest of the light to pass through. The second mirror reflects blue light into a second photo-tube, allowing the remainder, which is principally green, to enter a third photo-tube. The transmitting circuit has a channel width of 14.5 megacycles. Green carrier, sound subcarrier, blue subcarrier, and red subcarrier are transmitted at 519.6, 524.1, 526.3, and 528.2 megacycles, respectively. Pictures were transmitted half a mile in a recent public demonstration (at Princeton, New Jersey on January 29, 1947) and were received perfectly. Recent work in the RCA laboratories makes it seem likely that band widths can be narrowed by mixing the color components before transmission.

(*Continued on page 248*)

The Hydrides— Compounds of the Future

By HARRISON C. WHITE, '50

ROCKET engine fuels; pyrophoric materials; drying agents; powerful reducing agents for the production of rare metals and fissionable elements — these are just a few of the capacities in which the hydrides will be utilized in the future even more than in the present. Indeed, the field of application of the hydrides is tremendous in its scope, for it ranges from organic and inorganic chemistry through metallurgy to nuclear physics.

Yet it is only within the past decades that hydrides have received enough attention to warrant more than a few lines in a reference text, in spite of the fact that as far back as 1810 and 1811 Davy, Thénard, and Gay-Lussac observed the partial reaction of hydrogen with alkali metals. In the period between 1811 and 1937 sporadic research was carried on by a few individuals and a few patents were granted; for instance the alkali earth hydrides were first investigated by Moissan and Von Lengyel in 1898. In the main, however, the field was a neglected one. Furthermore, many of the research workers in the field ran into technical difficulties in the preparation of the hydrides which were great enough to throw them far off the track as far as the formulas and properties of the hydrides were concerned.

Then Dr. P. P. Alexander entered the field in the 1930's. His work was so rewarding that in 1939, Ventures, Ltd., a farflung Canadian industrial organization, financed the founding of Metal Hydrides, Inc. Since that time the staff of this fledgling corporation has increased from three to nearly one hundred, while the daily production of hydrides has increased from a few pounds to several tons. During the same time the number of known hydrides has increased to a point where it is believed that almost every element in the periodic table forms at least one hydride.

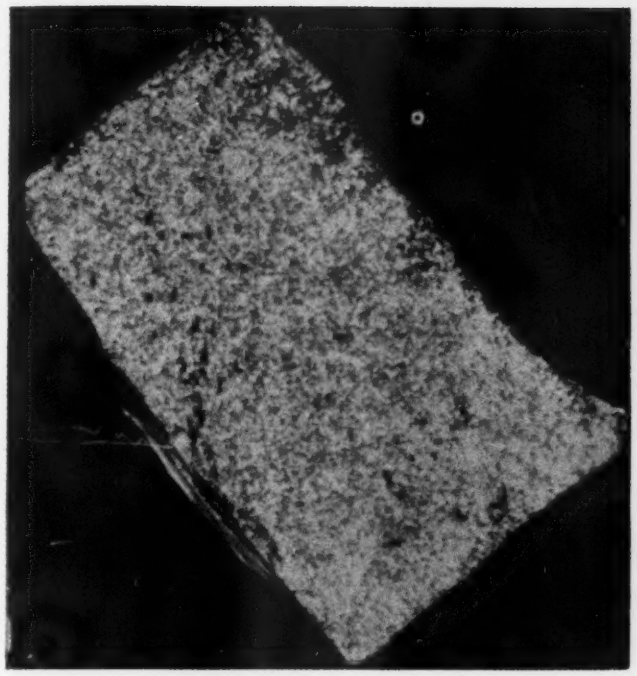
Most of the hydrides — certainly all the metal hydrides — have at least two properties in common: the valence of hydrogen is -1, and hence the hydrides behave much like halides; and any hydride can be dissociated thermally into hydrogen and the combining element. The temperature at which the latter occurs varies considerably; certain transition-metal hydrides will dissociate vigorously at room temperature, while tantalum hydride must be heated to 1200° C. before dissociation begins. In other respects the hydrides differ quite widely. Some of the hydrides such as water and hydrochloric acid are very familiar substances, while others are comparatively unknown as yet. We shall direct our interest to the latter class, for obvious reasons.

Usually the hydrides are classified according to whether they are formed by metals or non-metals, although this classification is useless in the case of complex hydrides containing both a metal and a non-metal. The metal hydrides are subdivided into the saline hydrides and the metallic hydrides. Originally it was believed that most, if not all, metal hydrides were not true compounds, but only occlusions of hydrogen in the metal. In recent years, however, it has been shown quite conclusively that most metal hydrides are true compounds, although the investigation of the properties of metal hydrides is rendered quite difficult by the fact that in addition to the hydrogen forming compounds with the metals, it also forms solid solutions in which varying amounts of hydrogen are dispersed interstitially in the crystals of the metal. In the case of gaseous hydrides which are formed mainly by non-metals, definite identification of the hydride compound is made quite simple by the use of fractional distillation; but with most of the metal hydrides reliance must lie principally on thermal studies and experiments which show the components of the hydride to be present in stoichiometric quantities. Also, the dissociation curves of the hydrides are quite often plotted: definite breaks, which would not occur with occlusions, in such a curve indicate that the substance under investigation is a definite compound.

The saline hydrides, which are formed principally by the alkali and alkali earth metals, resemble the corresponding halide salt in many ways; for instance, the crystal structures are almost identical, and the compounds of both classes can be fused and then dissociated electrolytically. In the case of hydride electrolysis,

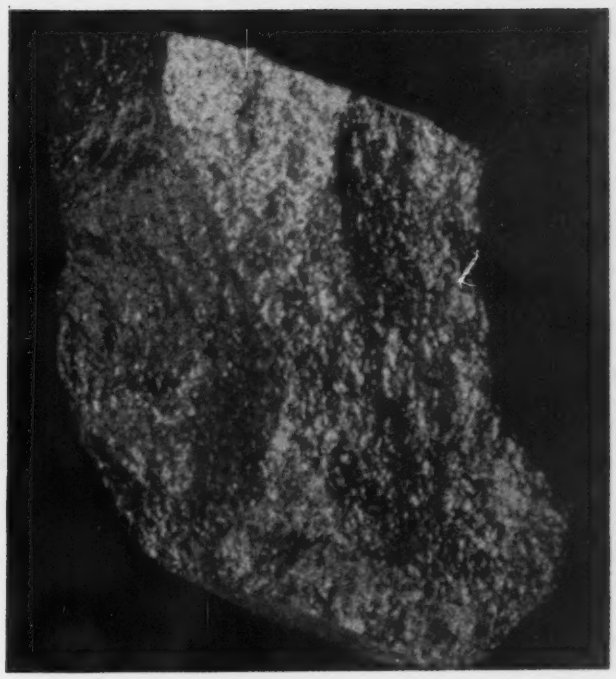
A row of gas-fired furnaces used in the production of huge amounts of calcium hydride

Metal Hydrides, Inc.



Metal Hydrides, Inc.

Cast zirconium as produced by the hydride process



Metal Hydrides, Inc.

A sample of titanium metal from a hydride process batch. Government laboratories are interested in titanium for structural use, as it is the ninth most abundant element, and is lighter than steel

hydrogen is formed at the anode; it is in this way that we know the hydrogen has a negative valence in hydrides. The saline hydrides in addition are extremely hygroscopic; they rapidly decompose into hydrogen gas and hydroxide if left standing in the air, hence they must be handled carefully in sealed containers. The metallic hydrides closely resemble the metals from which they are formed, although the hydrides are much more stable — in fact many pyrophoric metals form inert hydrides. In addition, they are non-hygroscopic and can be preserved indefinitely in air.

All of the metal hydrides are soluble in fused salts, but not in inert solvents. Many of them are quite stable, as is evident from the following table.

Hydride	*Heat of Formation (kcal.)*
Cerium hydride	42.26
Praseodymium hydride	39.52
Titanium hydride	31.10
Zirconium hydride	38.90
Calcium hydride	51.10

It would be well to note that a number of complex metal hydrides, such as lithium-aluminum hydride, can be formed, many of which have already proved to be quite useful.

The metal hydrides are, when heated, good reducing agents, CaH_2 and $LiAlH_4$ being among the most powerful. The hydrides are such good reducing agents because the hydrogen liberated by heating is in an unusual, nascent form, whose nature is not fully understood. One very important use of such hydrides as CaH_2 is in the reduction of refractory oxides of metals such as titanium, zirconium, chromium, thorium, and others. It is also possible to produce very useful hydrides or nitrides by cooling the reduced material in an atmosphere of either hydrogen or nitrogen. As a matter of interest it might be stated that the uranium used in the first atomic pile, which was constructed at the University of Chicago, was prepared at the plant of Metal Hydrides. In addition to the production of pure metals, hydrides are often used to reduce a mixture of refractory metal oxides to form true alloys. These alloys, which are produced in the form of powders suitable for use in powder metallurgy without any preliminary grinding, are formed at temperatures below the melting point of either of the metals involved.

The use of metal hydrides is not confined to the field of metallurgy, however, for they are used both as reducing and condensing agents by the organic chemist and as super-drying agents in industry. Furthermore, several of the metal hydrides which can be vaporized furnish a convenient means of metal plating: The metal is converted into its hydride which is then vaporized over the surface to be plated; the hydride is so easily decomposed by the heated surface that the metal plates out of the hydride onto this surface in a uniform layer.

Hydrocarbons have found an analogue in the series of the hydrides of boron, although this fact is not widely known. In spite of the fact that the hydrides of boron have been known for quite some time, they were so difficult to prepare and so dangerous to handle that only a negligible amount of research was conducted on them. Now, however, recently discovered methods of preparation discussed below have brought many of the boron hydrides — especially diborane, B_2H_6 — into the realm of practical use. Nor are the boron hydrides the only non-metal hydrides which may prove useful, for silicon forms an analogous series of hydrides. More and more interesting properties of non-metal hydrides are being discovered, but at the present all such information is restricted for security reasons.

Now that we have a general idea of the nature of the hydrides, we can go on to the description of specific examples. (*Continued on page 258*)

Isotopes for Sale

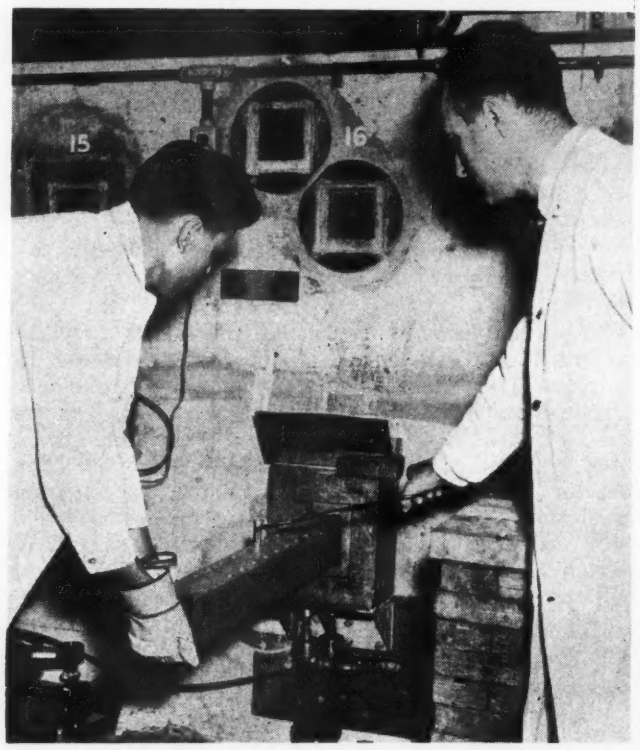
By HAROLD CONROY, '48

INTENSIVE and wide scale research with radiations and radioactive materials now made available in relatively huge quantities by the development of the chain-reacting uranium pile, invented for the production of plutonium for the atomic bomb, is opening the door to new basic knowledge and new discoveries of great value to mankind. The uranium pile's importance grows from the fact that it can make available to science radioactive materials — fission products and other radioisotopes — in hitherto undreamed of quantities. In the case of Carbon 14, perhaps the most important radioisotope, we can now produce thousands of times as much as we could with the cyclotron. In other instances, the yield is a *million* times greater.

Uses for radioactive materials in research fall mainly into four categories — radiometric analysis, tracer experimentation, radiography, and studies into the nature and effect of the radiations themselves.

Investigation into the biochemical reactions in the thyroid gland is a recent application of radiometric analysis, and one which will suggest the broad possibilities of radioisotopes in this field.

If the thyroid gland works too rapidly, the human system burns energy at too high a rate; when it operates sluggishly, the whole system feels lazy, "under par." If the iodine balance in the gland is upset, perhaps goiter results. To understand the thyroid mechanism, the chemist would like to analyze not only the iodine content in the gland, but also the rate of iodine entry into and exit from it. He cannot, of course, take a sample of thyroid from a man as easily as from a laboratory animal; and even if he could, taking a gland out to examine it means surgery, so that a progressive experiment showing the rate of iodine intake would be



Monsanto Chemical Co.

A sample of element to be activated is placed in the graphite carrier block and pushed into the center of the pile. There it will remain under constant neutron bombardment for one to two weeks

impossible. Furthermore, the total amount of iodine in the tissue is so small that ordinary chemical methods of measuring it are extremely difficult to use satisfactorily.

The use of radioactive iodine can solve this problem, since as small a quantity as ten million atoms of it can be detected easily at some distance by electronic instruments. A radioactive iodide is fed to the patient, and, with the aid of an electronic detector placed on the front part of the neck, the entry of radioiodine into the thyroid is accurately identified.

Once radioactive iodine became available from cyclotrons (1936) and was used for such measurements, results led quickly to its experimental use in larger amounts as a therapeutic agent in treating exophthalmic

Energetic isotopes are purified in "hot" cubicles by remote control through two-foot concrete walls. Reactions are followed through a periscope

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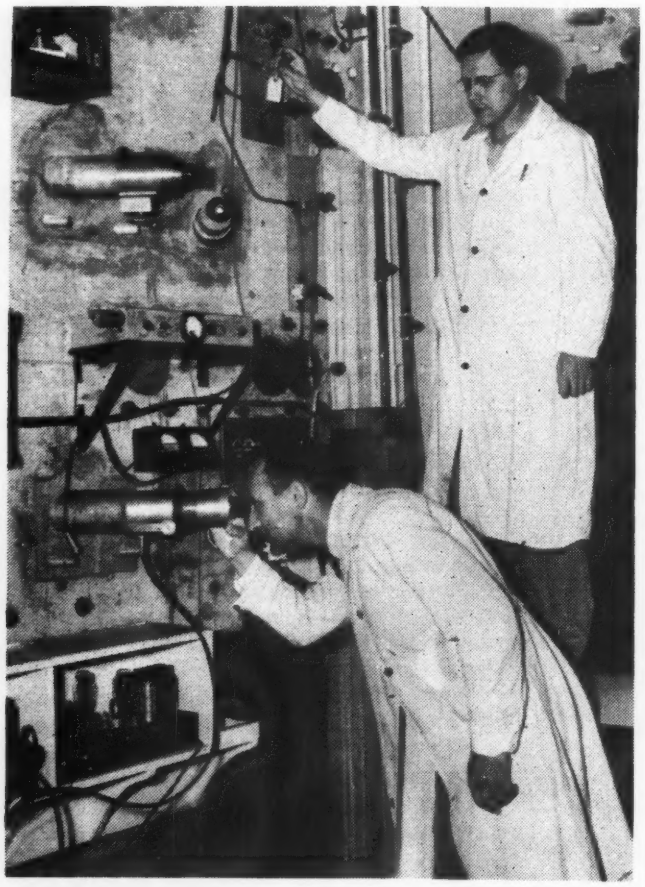

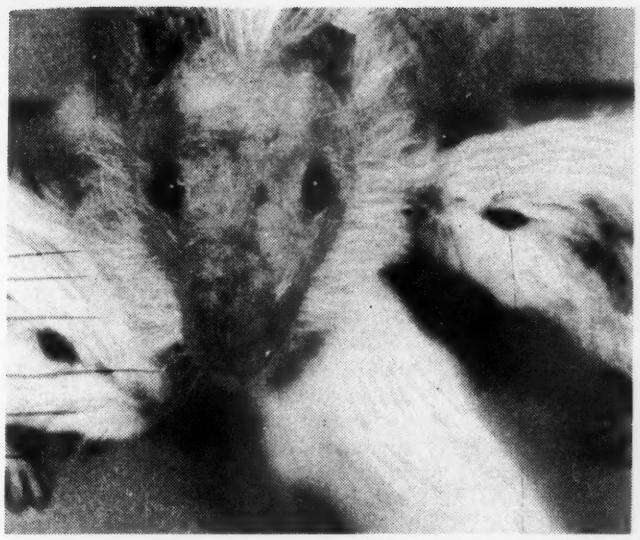

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Exposure to a single dose of beta radiation cost this guinea pig most of her hair, part of her ears. Longer exposure would have destroyed cells, causing wasting tumors and death. Thus, studies of this type are directly concerned with the fundamental nature of cancer

goiter and thyroid cancer. Though once not generally available because of the cyclotron's limitations, radioiodine is now produced by the uranium pile at the Clinton Laboratories of Monsanto Chemical Company in satisfactory quantities.

An important field of tracer research comes with radiocarbon (Carbon 14). With this substance on hand in large pile-produced amounts, biologists are working to find out how plants use sunlight and carbon dioxide to make energy-containing compounds, and how man reverses the process to get the energy back. Investigators can introduce Carbon 14 into plant and animal life processes instead of ordinary carbon (or Carbon 12). They can then trace with electronic devices the course of the carbon and measure the amounts used in a way similar to that used in the case of radioiodine in thyroid. The importance of a continuing supply of C-14 for research in photosynthesis, not to mention other organic chemical problems, is so great that the operation of chain-reacting piles could be justified for the production of C-14 alone. It is entirely possible that the things we will learn from using C-14 may be as significant and as valuable to mankind as the discovery of nuclear fission itself.

While radioisotopes have the same chemical properties as non-radioactive elements, the distinguishing characteristic of radioisotopes is the ability of their radiations to produce ions. Ionization produces infinitesimal but measurable electric currents and causes chemical and physical changes in the surrounding medium.

The best known and most dramatic use of the ionizing property of radiations is in the treatment of diseases, particularly cancerous ones. Radiations tend to destroy living tissues. By proper use of these radiations, however, cancer tissue may sometimes be destroyed more rapidly than healthy tissue. In the past, doctors have used radium and X-ray treatments but more recently radiophosphorus and radioiodine have been tried in certain cancerous diseases with some measure of success.

Production

Radioactive isotopes are created in chain-reacting piles by two processes: (1) the fission of U-235 nuclei, which maintains the chain reaction, and (2) neutron adsorption by nonfissionable nuclei placed in the pile for the purpose. The former — the so-called "fission products" — exist as a mixture of many radioactive species, each free of significant amounts of stable (carrier) isotopes, in a large amount of the parent substance, uranium. The desired radioisotope must subsequently be separated from uranium and from the other fission products, as well as from any neptunium and plutonium formed by neutron capture in U-238. In the chemical process actually used, the fission products are separated from the mixture either as individual radioactive elements or as groups of elements.

The methods in use at the Manhattan Project for the preparation of fission-product radioisotopes were developed to meet certain specifications, which in turn were set by the biological work in which the radioactive materials were to be used. The radiation intensities involved in working with mixtures of fission products at the curie level (a curie is defined as the quantity of radioactive substance equivalent to 3.7×10^{10} disintegrations per second) required the invention and use of chemical processes which were remotely controlled from behind specially constructed lead and concrete barriers and were economical of material. The methods used permit the isolation of nearly every fission product of

One man keeps an eye on the radiation meter, while the other pours irradiated tellurium from the container during the purification process to extract radioiodine. Lead bricks are the only protection needed

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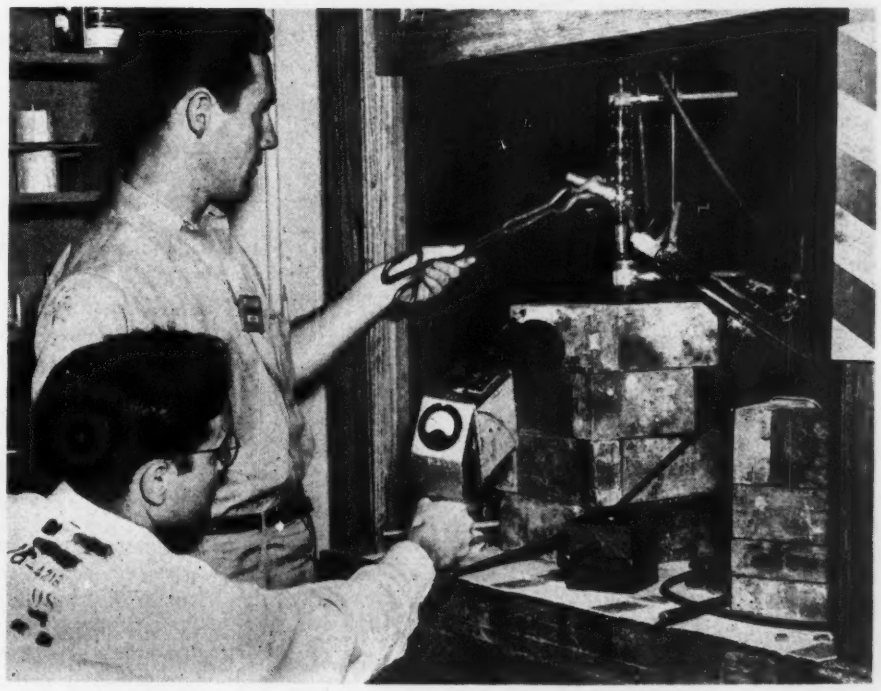

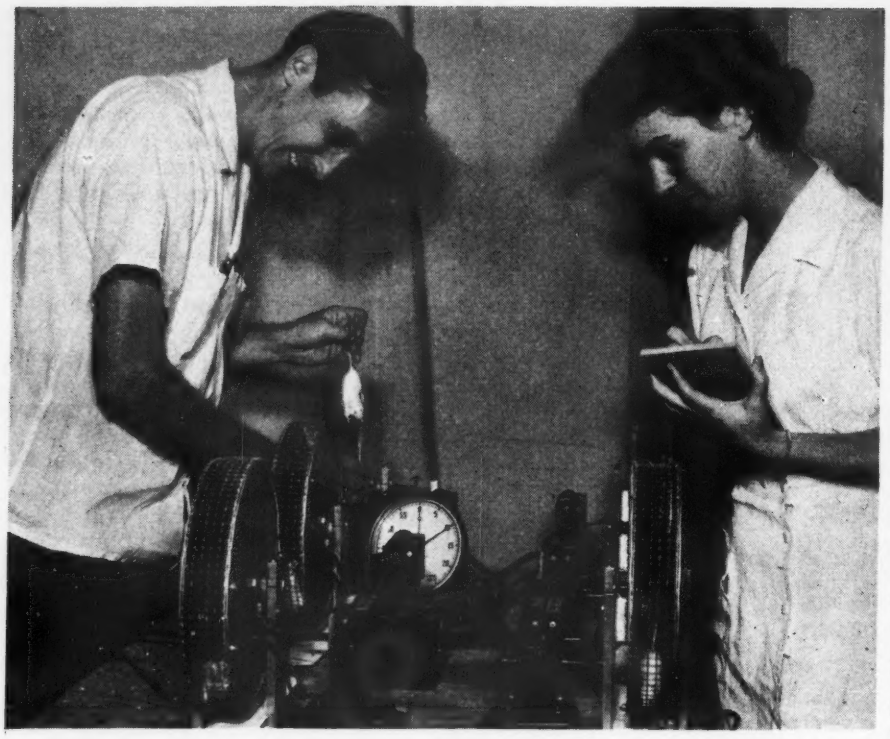

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Studying the effects of radiation on mouse vitality at the Clinton Laboratories, indirectly leading to more information about cellular growth, and thus more about life

After neutron treatment is completed, radioactive samples are removed and placed in lead safes for temporary storage Monsanto Chemical Co.

half-life from one week to thirty years occurring in significant amount. Those fission-product radioisotopes which can now be isolated from pile uranium in moderate quantity and in good quality are as follows: Zr 95, Cb 95, Y 91, Ce 141, Ce 144, Ba 140, Sr 89, Sr 90, Pr 143, Nd 147, Eu 156, Cs 137, Ru 103, Te 127 and Te 129.

In addition to the fission products obtained from the disintegration of uranium, there are produced nonfission radioisotopes by irradiation of elements other than U which are placed in the pile. These nonfission isotopes may be either simple elements which have absorbed one or more neutrons but have still retained the same chemical properties of the parent, such as Na 24 and S 35, which are made from Na 23 and S 32 respectively, or they may have originated from transmutation reactions. An example of the latter is the production of Carbon 14 from Nitrogen 14 or Phosphorus 32 from Sulfur 32. Those isotopes resulting from the simple adsorption of neutrons, without transmutation, always contain more or less of the stable parent isotope, which is called a "carrier," but the isotopes originating in transmutation may be effectively purified by taking advantage of the difference in chemical properties.

Only a small number of elements are known to undergo (n, p) or (n, α) (which mean transmutation with adsorption of neutron and expulsion of proton or alpha particle respectively); however, the few which do this yield some of the most important radioelements. Besides the two previously mentioned there are also Ca 45 from Scandium 45, H 3 from a Li 3 salt, and S 35 from a chloride.

Because of the desire to make available the greatest number of isotopes, the Manhattan Project usually supplies these carrier-free species in the irradiated material, unseparated from the parent and radioisotopes of the parent. In these cases, as in all others, any pertinent experience in a particular separation is made available by the Project. In a few cases, where the element is rare or where the separation is too hazardous to be accomplished without special facilities, separated material is supplied.

Besides the radioactive isotopes mentioned there are available small experimental lots of stable, nonradioactive isotopes of nongaseous elements which have been concentrated for Project nuclear researches using electromagnetic pilot plant facilities of the Tennessee Eastman Corporation at Oak Ridge. Studies have begun on production costs and on the obtainable quality and quantity of concentrated materials. In general, production is quite expensive, and it is difficult to achieve the high isotopic purity desired for many nuclear studies.

Charges are made for irradiated materials and processed isotopes, a reasonable charge being considered to be one based on the "out-of-pocket" operational expenses necessitated by the nonproject production and service program. In other words, charges do not include costs of rental, or construction of plant and major facilities, or of research and development directed towards the supplying of isotopes in general.

(*Continued on page 244*)

"... AND IN THE WAKE OF THE GIANTS CAME THE LITTLE PEOPLE"

Sixth in a series of articles on Elementary Astronomy

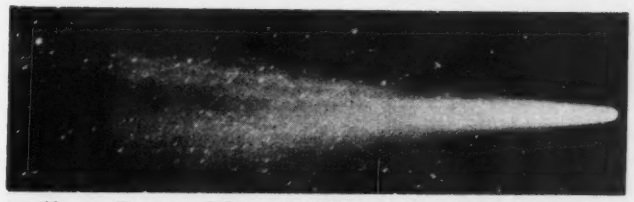
By PETER B. NEIMAN, '48

"WARS, pestilences, famine and the death of kings" were, for thousands of years, attributed to mysterious bodies, appearing for a few days, lighting up the sky in a terrifying blaze of glory, and then fading away into the depths of space, not to be seen again for hundreds of years. They were the "Kometes", or long-haired stars.

It was not until 1577, when the great astronomer Tychoe Brahe measured the parallax of a comet appearing that year, and found that its parallax was smaller than that of the moon, and therefore must be a celestial body, that the study of comets began to emerge from superstition to scientific fact. Perhaps the last time that the world as a whole was terrified by the appearance of these "fireballs sent by an angry God" was in 1682, for it was then that Halley, using Newton's newly discovered laws of gravitation, calculated the orbit of a comet appearing that year and predicted its return in 1758. It was on Christmas Day, 1758, that the comet blazed into view, definitely establishing comets as scientific phenomena, and bringing slightly useless fame to the long dead Halley.

Comets are perhaps the strangest bodies in our solar system, for while they are the largest bodies in the system, some of them being many hundreds of times larger than our sun, their actual mass is too small to be accurately measured, being certainly less than one hundred thousandth of the earth's mass.

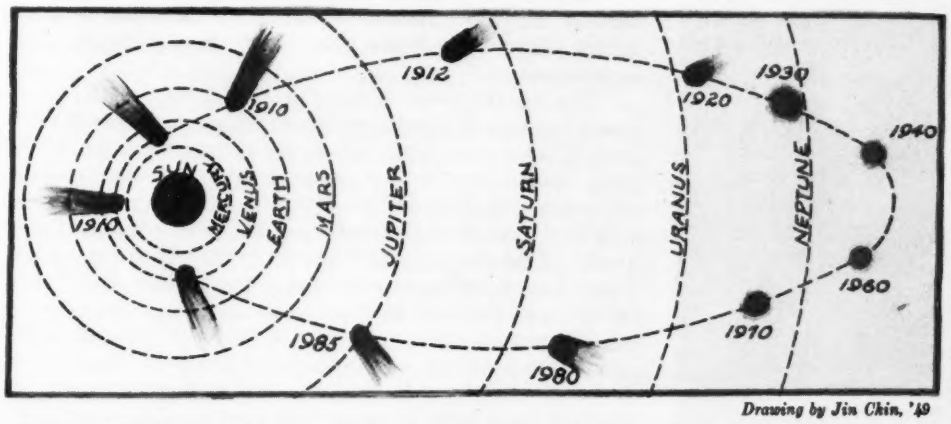
Astronomers have divided comets into three parts. The first is the head or nucleus, which is probably made up of fine meteor particles. Surrounding this is the coma, a thin gaseous envelope, which in turn spreads out in back and forms the tail, which is made up of highly rarified gas, rarer than the best vacuum produced on earth. The nucleus varies from ten, to several hundred thousand miles in length. (Compare the diameter of the earth—eight thousand miles.) The tail of the comet is often many millions of miles long. That of the great comet of 1843 was more than five hundred million miles long, longer than the distance from the sun to Jupiter.



Halley's Comet, May 5, 1910

All comets travel in fairly well defined orbits about the sun. About seventy-five per cent of these orbits seem to be parabolic. Since, however, the parabola is the limiting case between the ellipse and the hyperbola, it is highly probable that most comets do not fall in from infinity, round the sun, and recede to infinity, as they would if they were truly parabolic, but instead describe incredibly long elliptical orbits, extending far out of our solar system, and part way to the stars. These are the "long period comets" appearing once in many centuries. There are also many comets moving in elliptical orbits with a period of less than a century. These "short period comets" are, for the most part, faint. Halley's comet is a brilliant exception. The shortest period is that of Encke's comet, which appears every 3.3 years.

Comets shine mostly by reflected sunlight, giving off a spectrum that shows the presence of nitrogen, carbon monoxide, cyanogen and other gases. The only *atom* whose presence has been definitely established is sodium, which is responsible for many comets shining with a beautiful golden color. The great comets of 1910 and 1927 gave off such an intense golden light that the contrast with the blue of the sky was great enough to make them visible at mid-day, within a few degrees of the sun.



Drawing by Jin Chin, '49

Orbit of Halley's Comet. Note the position of the tail in relation to the sun. The intersection of the earth's and the comet's orbits are the points where the earth will receive slight meteor showers (May 4)

The tail of a comet is a highly unstable appendage, shrinking to almost nothing when the comet is out in space, and rapidly expanding to lengths greater than the distance from the earth to the sun as it nears the sun. It cannot be a fixed appendage, for at the speed with which many comet nuclei sweep around the sun (about three hundred miles per second) the tail would have to move with a speed near the velocity of light if it were fixed. The direction of the tail is always nearly opposite to the sun. (See figure.) This is caused by the pressure of solar radiation falling upon the extremely flimsy tail, and also by the ionization of matter in the coma, which drives matter towards the tail, as the comet rounds the sun.

This material, flowing outward from the tail, and into space, can never rejoin the head. Since the coma furnishes matter for the tail, it follows that a comet must be continually disintegrating. In addition to this wastage, a comet that comes very near the sun or a large planet is subjected to enormous disruptive tidal forces that tend to loosen and split the comet.

This combination of destructive forces affords a

(*Continued on page 262*)

Your Supper—Minus Water

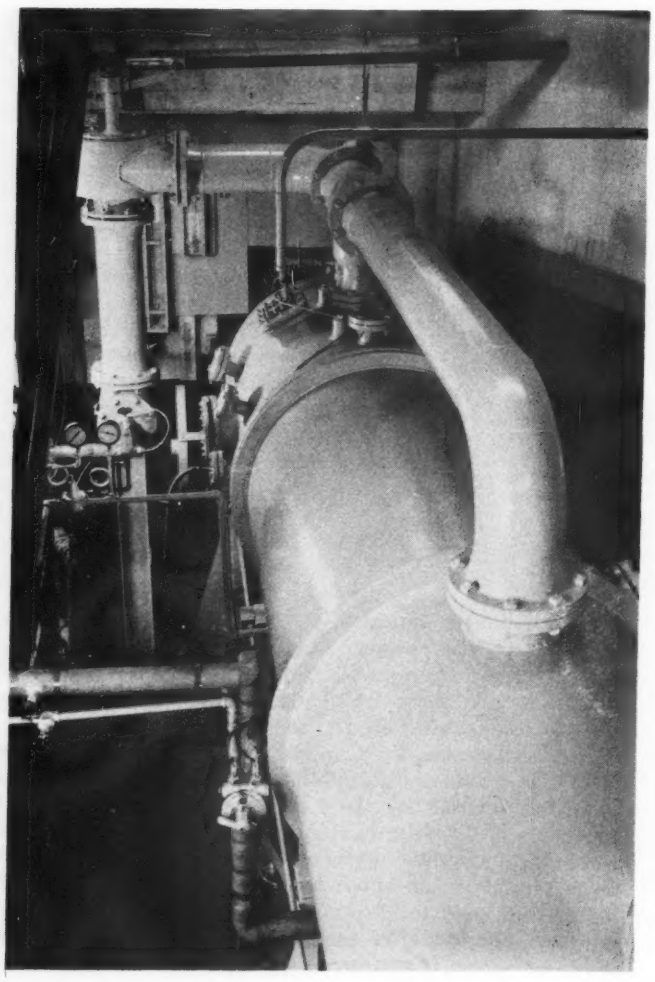
By SIDNEY L. SMITH, 6-47

YOUR dinner in a pill? It is not so impossible as you may once have thought! Our modern world, with its vast increase in the speed and complexity of existing systems of production and transportation designed to support human existence, has recently seen the development of several significant trends. One of the most obvious of these, correlating the two fields, is the trend toward *concentration* — that is, a concentration in production designed for ease in transportation. Whether the works of Shakespeare "concentrated" into a "hip-pocket" edition or a normal dinner into a box labeled "K-Rations," we see in many things about us the reflection of this tendency.

In the field of nutrition, this trend has become so significant that it demanded a great new type of food industry. With its early beginnings at the turn of the century, developing slowly and with difficulty at first, but given huge impetus by the recent war when the "trend" became an urgent need, the present industrial scope of concentration, drying, and dehydration in the food industries is broad indeed. Unfortunately, due perhaps to the composition of the industry (thousands of small, privately owned firms), research along the lines of dehydration has not kept pace with the rapid expansion encouraged in the industry by necessity. As a consequence, dehydrated products of many sorts are admitted even by their makers to be far from perfect in some respects; and industry leadership is calling more and more for research work with the aim of improving these products.

A belt drier moving through a vacuum provides an efficient method of continuous dehydration of foods in the M. I. T. laboratories

Food Technology Department



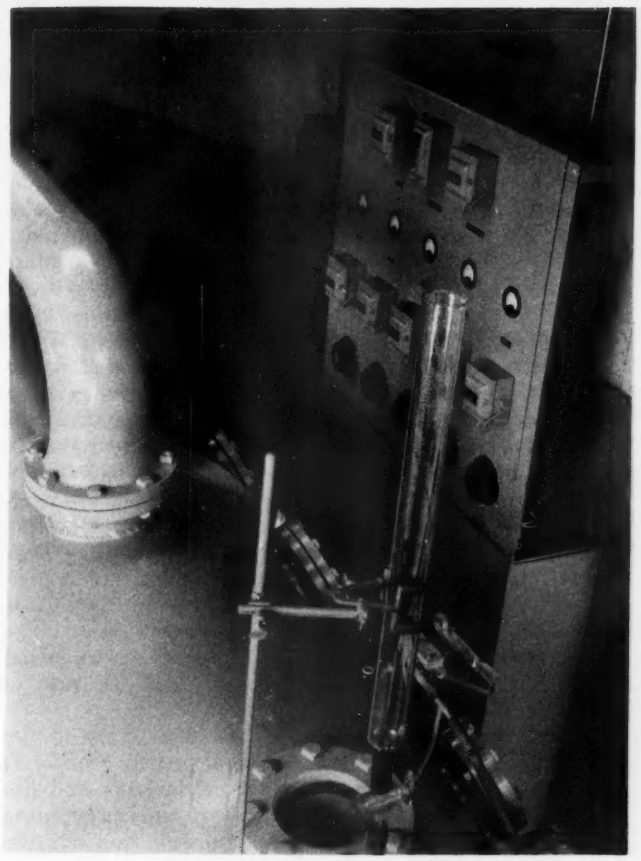
Dehydration in itself has many advantages: from the point of view of transportation, it eliminates the cost of shipping all the water otherwise associated with a particular product; from the point of view of nutrition, it will often prevent the spoilage of "perishable" foods when being shipped to distant markets — and in this connection it has proved a boon to producers such as fruit growers who can dehydrate the ripened fruit in season for later distribution, eliminating the losses incurred in flooding the market at harvest time, and providing a more steady supply to the consumer.

Dehydration as a method of food processing competitive with canning, for instance, offers potentially bright prospects. It is the opinion of many who have produced dehydrated products that the process of dehydration, when properly done, will preserve flavors better than obtained by the present canning methods. "When properly done" is the catch-phrase, the reason behind all the present research-led development in many different adaptations of drying methods and equipment.

During the war, when the "far-flung battle line" was a matter of grim fact requiring a vast network of supply lines stretching tenuously about the globe, shipping space was at a premium and the outstanding advantage of dehydrated products was obviously their relatively small bulk compared with the original fresh foods. This proved a great saving in the meeting of our Lend-Lease commitments and later in the supplying of our own fighting men as well.

There were other advantages too: dehydrated foods were less inclined to spoilage under field conditions, lack of refrigeration and so on; also they could be packed quite well in paper containers rather than steel ones, effecting an appreciable saving in the metal. A wide range of foods were sent to the front in dehydrated form, and the industry expanded with remarkable rapidity to meet the demands. Today, the industry is working to expand its peacetime markets to meet the wartime capacity. World food projects such asUNRRA will use a part of this output. In fact, dehydration may well be considered one day as the modern answer to the Malthusian theory. However, with this happy state not yet upon us, the industry certainly faces a problem in this respect.

The development of the dehydration industry has continued since the end of hostilities, tending toward a greater variety and a better quality of products till today there are few branches of the food industry in which dehydration does not or could not play a part. The number of products processed in this way is steadily



Food Technology Department

A feed mechanism for a vacuum belt drier. In the background, the control panel may be seen

increasing: dehydrated meats, vegetables, fruits, juices, soups, milk (whole milk or casein), coffee, eggs (whole eggs or whites only), and so on.

Individual users find adding water to a little powder a convenient way to make their morning orange juice and coffee. Soups are much more portable in dried form, though at present they are sometimes difficult to "restore" properly. Dried eggs make fine cakes, baked custards, and the like. Industrial and institutional users find them much easier to prepare (not to mention ease of storage) than those straight from the hen. Dried milk was used with success by our Pacific fleet in making ice cream on shipboard for the men, and is today being used on a larger scale by many ice cream manufacturers here at home.

The magnitude of the industry, particularly that part processing milk and eggs, has reached quite sizable proportions. 1945 figures on dehydration of eggs estimated approximately 85 egg-drying plants with a capacity of 300,000,000 pounds compared to 18 plants in 1940, with an output of 7,400,000 pounds. 1943's need of dried whole milk and defatted milk solids was estimated as 1070 million pounds, and the annual consumption has increased since. Though no over-all figures are readily available for other dehydrated products, it is evident that, considered as a whole, dehydration is playing a major role in the food processing industry.

Since dehydrated foods are processed primarily for eventual consumption, one of the chief requirements of the final product is that it be palatable — that is, not just edible but edible with reasonable ease or pleasure. Processing of any kind is liable to influence the taste (flavor, texture) of a food, and dehydration is a form of processing more radical than most. As a consequence, early dehydration methods often adversely affected the taste of the restored product.

With later development in the field, conditions of dehydration were altered and varied until those were found which seem to give optimum qualities with regard to palatability. Unfortunately, however, much of the earlier product had of necessity to be sent overseas to our armed forces, and it has been said that returned GI's form a nucleus of what seems to be a fairly general consumer prejudice against dehydrated foods. Continued improvement in the quality of these products will eventually break down this early resistance; meanwhile, the very novelty of such things as dried eggs and milk makes them the victim of such humorous attempts as the following excerpt from a pamphlet distributed by the Red Cross to our Japanese occupation troops:

SOLDIERS' GUIDE TO THE UNITED STATES

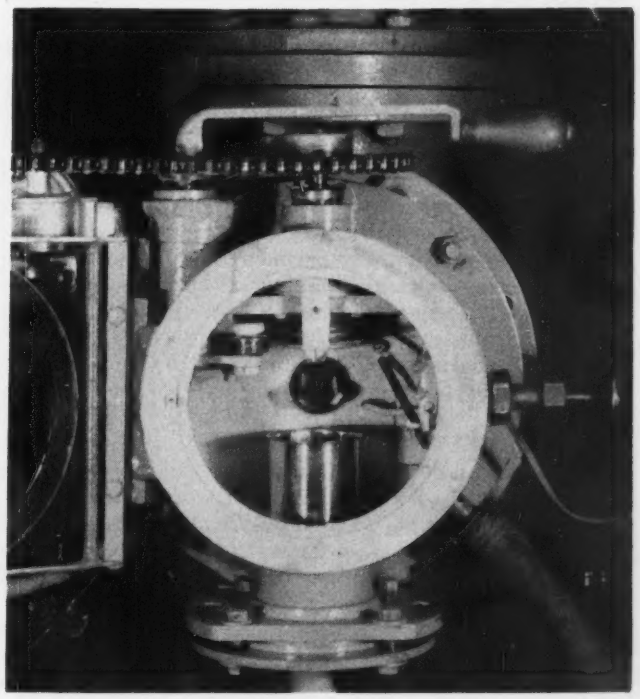
In view of the fact that some of the personnel now overseas have been forced to accept an assignment in the United States, we are printing this short and practical guide to that foreign country....

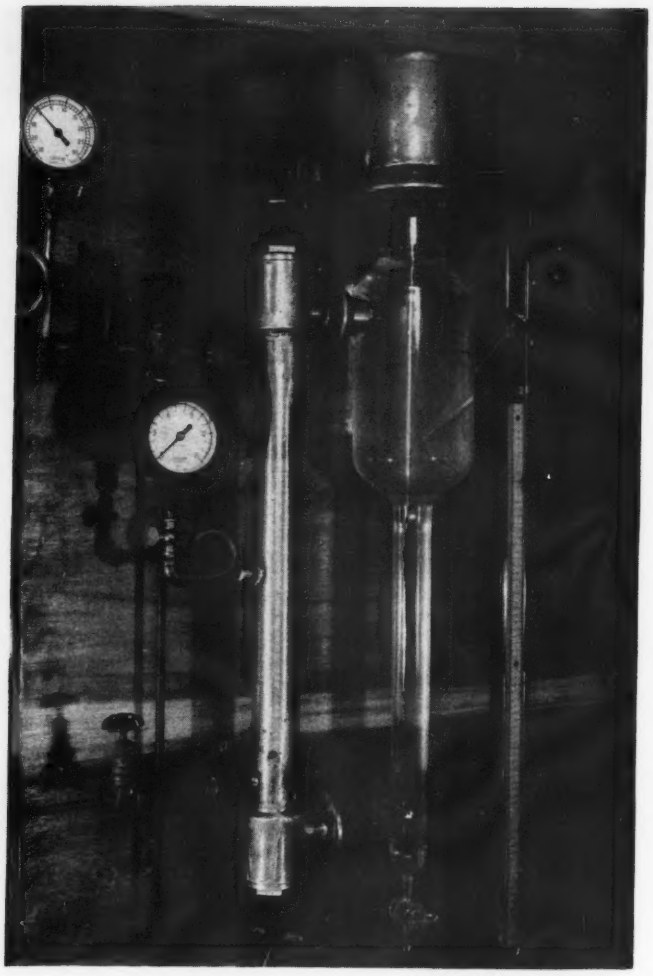
Food is generally plentiful, but in some localities powdered eggs are almost unobtainable. You will probably be forced to eat the shell covered kind on most occasions. Remember, do not eat the shell, simply crack the egg and toss away the outer covering. By the same token, dehydrated vegetables are almost extinct in the United States. Stores feature potatoes, carrots, spinach and turnips in their natural status. You will notice pieces of soil still clinging to these items. Wash before eating....

Another one of the requirements for dehydrated products is that they be readily soluble. It is fairly

By means of this apparatus, cans may be filled and sealed while still under vacuum. In the M. I. T. Laboratories, this setup has been used in conjunction with the vacuum belt drier in experimental dehydrations. Through the open valve, within the white circle, a can is placed automatically in position for filling

Food Technology Department





Food Technology Department

Liquids are preconcentrated in a vacuum before final and complete dehydration. The liquid is sprayed into a vacuum chamber and most of the moisture evaporates.

obvious that if the food has been processed by removing its associated water, it is prepared for eating by restoring this water. If the restored food is to be a liquid such as orange juice the dry powder must dissolve readily in water. If we are dealing with dehydrated vegetables they must absorb water with relative ease to be prepared readily.

Under certain drying conditions, complex organic changes can occur in the food structure which tend to decrease and eventually destroy altogether the solubility of the product. Experiments have shown these characteristics (ease of solubility) to be related to those of palatability mentioned above and similarly dependent upon the conditions of the drying process.

The third important requirement of most dehydrated products is that they have good storage qualities. Though removing the water from such foods as milk or eggs vastly increases the length of time they can be stored without deterioration, still it is possible over a period of months for chemical changes to occur rendering the foods unfit for consumption. Sometimes this is due to the absorption of gases, sometimes absorption of water from the surroundings, though neither of these is required in some instances. These factors tie in together to produce the end result, spoilage of the product. For instance, it has been shown that the fat content of dried milk is a factor in its ability to absorb gases and that the primary cause for the spoilage of powdered milk is the auto-oxidation of the fat.

Storage qualities, though dependent upon the conditions of dehydration, do not govern the rate of deterioration so directly as the conditions of *storage* — thus storing at relatively lower temperatures, and such devices as gas-packing and packing under compression are often more directly effective in improving the storage life than a variation in the *drying* conditions.

Temperature of storage is probably the most influential single factor, reports supporting a fairly general contention that dried foods, other factors similar, keep three to four times as long at 15° C. as they do at 37° C. Moisture content of the product also plays a significant part, reports showing that at all temperatures the rate of deterioration increased with increase in moisture content. The conclusion drawn was that to maintain quality during storage and transport, dried egg should contain not more than five per cent moisture and preferably two per cent or less. Various other estimates may differ quantitatively, but qualitatively they bear out the thesis. Since the final moisture content is controlled by the drying conditions, here is one factor we are able to influence on the production end. The dehydration temperatures also affect the eventual storage qualities of the product, as does the rate of cooling before packaging.

"Gas-packing" the product has been tried in the case of powdered eggs and several other foods. It involves evacuating the container or package and filling with some inert gas before sealing, thus preventing any oxidation-spoilage from atmospheric oxygen. Canadian investigators reported: The effect on keeping quality of packing in nitrogen, carbon dioxide, *in vacuo*, or in the form of compressed tablets was studied. Carbon dioxide alone had beneficial effect. Russian reports on the other hand seem to favor packing by compression, stating: "The storage life of egg products can be lengthened by compressing the product into brick form. Due to their greater density, bricks made of dried egg do not absorb moisture as easily as do egg powders. The lowered hydroscopic property of egg products in brick form is the cause of their stability."

In any case, egg powders and similar dehydrated products can be stored under proper conditions for periods of a year or more, representing an obvious improvement over the difficulties previously met with in the distribution of these perishable products.

It is possible to add small amounts of various harmless chemicals to dehydrated products to increase the solubility, or to act as anti-oxidants to improve keeping quality. Altering the form of the food to be dehydrated by some preliminary treatment such as cooking the egg before drying has sometimes been found to permit more extreme drying conditions. In one process milk is separated into skim milk and cream, both portions heated to 170 to 180° F. for fifteen to thirty minutes, then recombined and dried to a powder. Liquids are quite often concentrated before drying for reasons of economy.

But the obvious and generally most effective method of securing the best combination of desirable qualities in the dehydrated product is to determine and apply the optimum conditions for the drying process. These will of course vary with the particular product; also some consideration will show that in some cases they may represent at best a working compromise between conditions producing best palatability, solubility, storability qualities. Fortunately, this compromise is rarely a serious one since it appears in general that these

(*Continued on page 250*)

John Hancock Builds a New Home

By ROY W. JENKINS, '50

IN 1862, the John Hancock Mutual Life Insurance Company began business in one room near the Old State House in Boston. Today, its five thousand employees are scattered among five buildings, but within two years they will move into a new home which will be the most modern structure yet erected in the city. A masterpiece of design and architecture, it will have every possible arrangement for the efficient operation of the business.

Rising 470 feet from the street level to the top of the lantern tower, the 26-story addition to the present home office will be an imposing addition to Boston's scanty skyline. In fact, it will be one of the highest in the city, and from the observation gallery on the 26th floor, it will be possible to see 25 miles out to sea and 65 miles inland on a clear day.

Fay Foto Service

The primary excavation for the John Hancock Building almost completed

As with most tall buildings, the most difficult problem of design was that of the foundation. The building is located in a section of Boston known as Back Bay, which a hundred years ago was under water as the mouth of the Charles River. It was no surprise, then, that preliminary borings showed a 50-foot layer of fill and glacial silt overlying a tremendous bed of blue clay. And it is on this bed of clay that almost 90 per cent of the commercial buildings in Boston are built, either directly or on piles driven not more than 10 feet into it.

When the architects, Cram and Ferguson of Boston, designed this foundation, they decided to do the job right, to do it in the only way that would be absolutely dependable and in accordance with the highest engineering standards. Their final decision was to drive steel piles through the blue clay and onto the bed rock 155 feet below street level. It is worthy of note that this will be the first commercial building in Boston with this type of foundation.

The primary excavation of 22 feet was completed before the piles were driven, and after eight months of pile driving, the secondary and final phase was started — the removal of another 27 feet of fill and silt. It has been necessary to carry out this process in 20 x 60 foot sections into which the concrete for the foundation slab is immediately poured. This excavation has been done piecemeal, because, upon removing another 25 feet of fill, the whole top stratum of blue clay is exposed. If this layer of clay should lift up at all, or be forced up by hydrostatic pressure, it would cause a corresponding settlement in some neighboring area, and the possible collapse of one of the older, less stable buildings. Thus it is necessary to replace immediately the weight of fill removed by pouring the 10-foot thick foundation slab in these small sections.

Since the excavation had to be carried to the curb of the surrounding streets, provision had to be made for preventing these streets from caving in. Shoring piles, H-sections, were driven at eight-foot intervals around the lot, and as the excavation progressed four-inch horizontal sheathing was slipped in between the flanges of adjacent piles. These piles were then braced to a portion of the completed foundation — a method that proved its effectiveness by the complete absence of settlement in any of the heavily traveled streets that border the lot.

The final figures for the foundation show that 1567 steel H-sections have been used, and that of that

Pile drivers at work. On the right is the big stiff-leg derrick used to unload the piles from the semi-trailers. In back of the derrick may be seen the first section of the temporary ramp

Raymond Concrete Pile Co.

number, 1534 are of the 14-inch type weighing 117 pounds per running foot; the remainder are the 33-inch 200-pound type. The H-sections were delivered to Boston in lengths of 65 to 120 feet, but two-thirds of the piles had to be spliced to obtain the desired length. This operation was performed at a welding yard where the sections were held together in specially designed "trundles," while being spliced and welded. The jig assembly was constructed to permit rotation of the piles and all downhand welding. When completed, the finished splice on a 14-inch pile had a 9½-inch square plate welded on one side of the web and on each flange.

The welding yard, where the piles were unloaded from freight cars, was on the other side of Boston, and the problem of transporting the completed sections to the job site was one of no mean proportions. Some of these piles were 130 feet long and weighed 13 tons, and the only possible route to the job was through one of the most heavily traveled sections of the city, by narrow streets and around sharp corners. A specially designed cradle was mounted on a low-bed, semi-trailer truck, but when the piles were placed on this cradle there was still an overhang of as much as 35 feet, both front and rear. Nevertheless, after a 45-minute run, the truck would pull up beside the project, and the piles would be hoisted into the hole by a stiff-leg derrick.

To drive these overlength piles, it was necessary to use 128-foot driving leads, the longest ever used by Raymond Concrete Pile Company, subcontractors on the pile driving. The pile drivers were each equipped with a Vulcan 00 Hammer, which develops 31,600 foot-pounds in a drop of 40 inches. Two pile-driving rigs, with 128-foot leads, concentrated on driving the piles to the existing grade, which was then about 20 feet below street level. A third, smaller rig was equipped with a 25-foot steel beam follower which was boxed with three-fourth-inch thick plates to facilitate withdrawal from the sticky ground. The follower made it possible to drive the piles 25 feet below grade and onto the bed rock 155 feet below the street. Raising a pile to a vertical position in the leads, preparatory to driving, was a tricky job, particularly with the 33-inch type which weighed 13 tons. Instead of a wire-rope choker, a special shackle, passing through one flange and bolted to the web 30 feet from the top of the pile, was used, thus eliminating all slippage.

Raymond Concrete Pile Co.

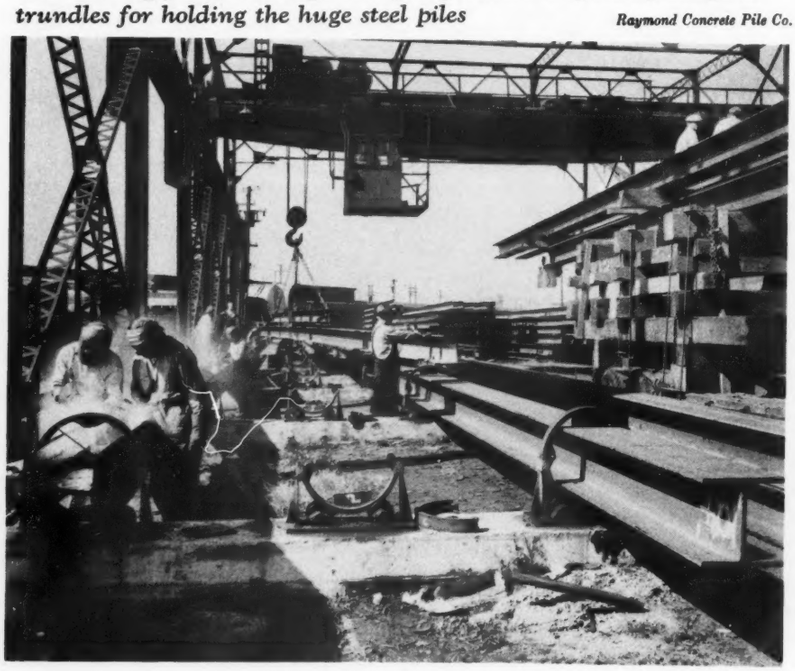
Going up! Thirteen tons of steel pile are hoisted into place preparatory to driving

At first, each crew drove an average of eight piles a day, but before the job was half completed, 20 and often as many as 30 piles were driven in a single day. It is a distinct credit to the experience and an honor to the reputation of Raymond Concrete Pile Company that in the eight months spent driving the 1567 piles, not a single man was seriously injured. The general contractors, Turner Construction Company, are equally proud of their outstanding safety record.

In this day of shortages, it is interesting to note that this project is outstanding in its conservation of critical materials. As an example, every conceivable effort is being made to circumvent the use of lumber in any of the operations normally requiring it. Almost all of the forms for the concrete are made of steel. There are, for instance, the 10 x 10 forms used for the foundation slab which utilize Robinson Steel Flooring and were designed for this job by the general contractors, and the Economy Steel Form Panels, which have proved very successful in that they are comparatively easy to

The welding yard, showing in the foreground the specially designed trundles for holding the huge steel piles

Raymond Concrete Pile Co.



handle, to strip, and to brace, and in addition they leave a smooth finish on the concrete.

Another good example of the conservation of lumber is the temporary ramp installed for the delivery of all types of materials required for construction purposes. This ramp was designed by the Engineering Department of the Turner Construction Company and was made up of structural steel bents with bracing panels on which were fastened precast, reinforced concrete slabs. These precast slabs were designed to be made of concrete with a compressive strength of 4000 pounds per square inch, and the entire ramp was designed to handle loads in excess of 25 tons. In addition to the fact that this ramp required no lumber, it is practically 100 per cent salvable and can be removed and reinstalled for reuse.

When Bostonians visit John Hancock's new home in the near future, they will be able to enjoy many innovations that make this structure both interesting and unusual, especially apparent in Boston where modern office buildings are scarce. A few of the outstanding features will be: high-speed elevators; escalators from the basement to the seventh floor; a new, exceptionally efficient system of air-conditioning; an auditorium seating over 1100; and an observation gallery on the 26th floor. But it will probably be at least two years before the building will be ready for occupancy. At this writing the foundation is nearly completed and within a month the erection of over 13,000 tons of structural steel will begin.

Fay Foto Service

A section of the foundation slab ready for pouring. In the background is the shoring braced to the completed section of the foundation

The Critic's Corner — a swell place for sidewalk superintendents

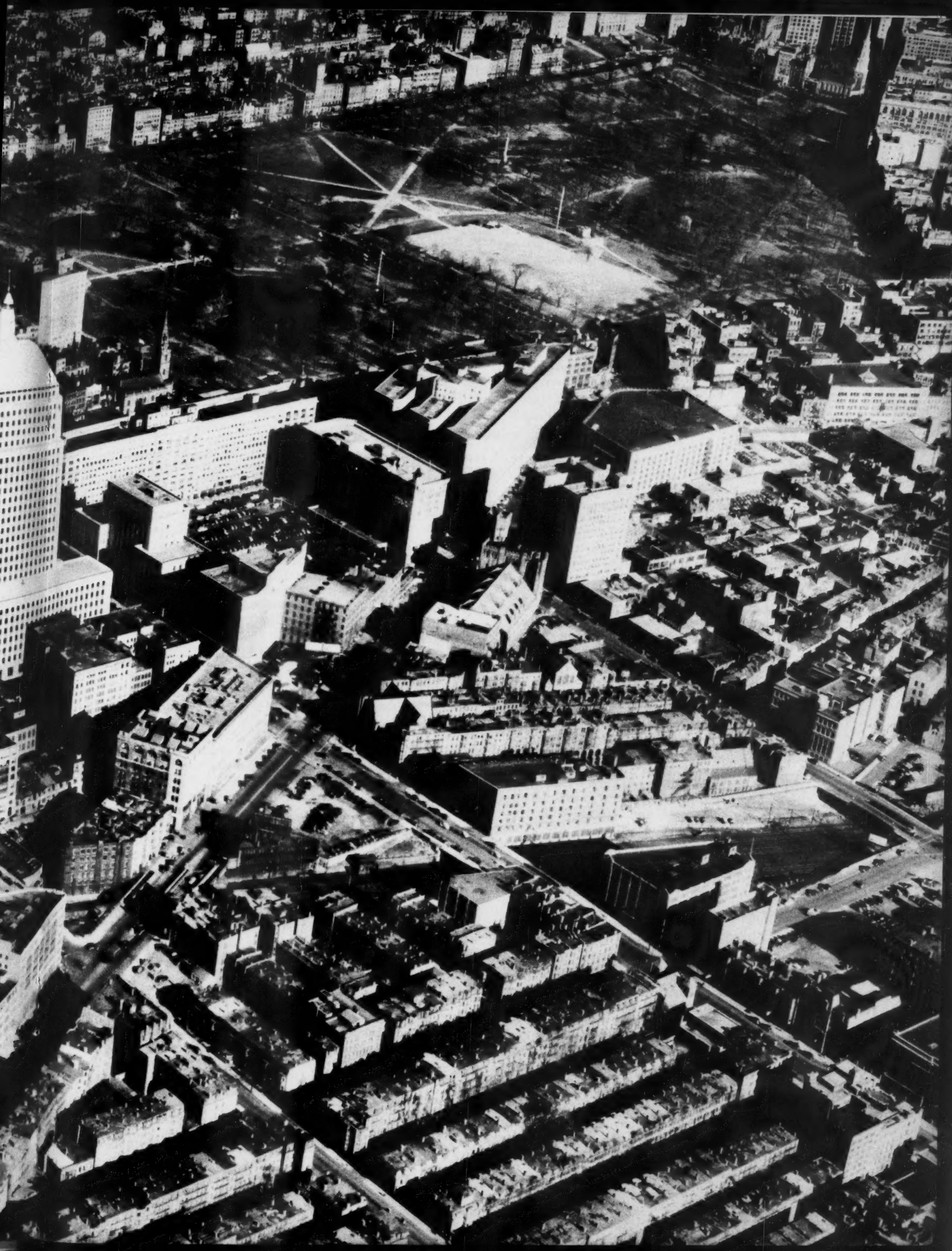
Fay Foto Service

The temporary ramp used at a later stage of the construction. Behind the ramp are the forms for the foundation walls

Turner Construction Co.

An airview of Boston, with a model of the John Hancock building added to show what Boston's future skyline will be like

Fairchild Aerial Surveys



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Can You Do It?

THE EIGHTH IN A SERIES OF MONTHLY BRAINBUSTERS

THIS MONTH: Three miscellaneous gems

Problem 1: Factor the number 359999.

Problem 2: Democharès has lived a fourth of his life as a boy; a fifth as a youth; a third as a man; and has spent thirteen years in his dotage. How old is he? — *From a collection of questions by Metrodorus, 310 A.D.*

Problem 3: At the close of four and a half months' hard work, the ladies of a certain Dorcas Society were so delighted with the completion of a beautiful silk patchwork quilt for the dear curate that everybody kissed everybody else, except, of course, the bashful young man himself, who kissed only his sisters, whom he had called for, to escort home. There was just a gross of osculations altogether. How much longer would the ladies have taken over their needlework task if the sisters of the curate referred to had played lawn tennis instead of attending the meetings? Of course, we must assume that the ladies attended regularly, and I am sure that they all worked equally well. A mutual kiss counts two osculations. — *From "Canterbury Puzzles."*

J. W. W.

(*Answers next month. Answers to last month's problems are on page 262*)

The Dragon's Den

E Pluribus Unum . . .

Among the most burning questions of our day is that of unions. People usually associate the term "union" with a group of workers getting together for one reason or another, because in union there is strength. However, there exist professional unions, some designed expressly for representing the professional in wages and hours disputes, others which are societies with the best interests of their *members* at heart.

Several of these professional societies, among which was the American Institute of Electrical Engineers, recently presented testimony before a joint Senate-House Committee in support of Bills S.360 and HR.1754. These bills would give professional employees freedom of choice in accepting or rejecting collective bargaining and would prevent the arbitrary inclusion of engineers in unions by prohibiting the forced grouping of professional and non-professional employees in bargaining units.

According to some Congressmen, collective bargaining for professional employees, when government sponsored, is unnecessary and inimical to the interests of the public. They therefore favored removing professional employees from under the authority of the NLRA. They also thought that professional employees should be able to handle their own affairs without governmental "interference and control."

The A.I.E.E. wished to inform its members of the facts of the situation, so it prepared a letter for circulation on its lists, both regular and student. The third paragraph enumerated the advantages to be gained by saying, "It would mean, however, that the unfair labor practice regulations established by the Wagner Act to regulate management-union relations would cease to apply. Hence, a group of engineers could not utilize the law to force management to deal with it; nor could it call upon the government to prevent management from discriminating against engineers participating in an employee organization." It would seem that the engineers themselves do not have much to gain by the passage of such an Act. In fact, the last phrase smacks strongly of N.A.M. anti-union propaganda. The National Association of Manufacturers probably would like to have these bills passed. Perhaps the A.I.E.E., supposedly an organization of engineers, made a typographical error. To soothe the minds of those many engineers not in positions of management, the A.I.E.E. has this old line: "On the other hand, engineers, individually and collectively, would have complete freedom of action on problems of professional and economic status." Yes, certainly — of course.

The licensing of professionals has always caused hot discussions among the groups affected. Doctors, dentists, and, in some States, engineers, have already had to fulfill the provisions of licensing laws. Now, it is the chemists' turn. There are many reasons given for licensing of chemists. They are directly or indirectly concerned with the public welfare. Their importance is especially evident in water supply control, clinical chemistry, pharmaceuticals, and food analysis. The American Chemical Society has put itself on record against any and all compulsory licensing procedures. Instead, they propose a plan of "national certification." And, to determine whether or not its members favored the plan, the A.C.S. commissioned its Committee on Professional and Economic Status to conduct a survey. Their statement: "Would such a system aid them in competition with the inadequately trained individual calling himself a chemist?" The A.C.S. has missed the mark if this is its aim, although having the best interests of its constituents at heart. The public is concerned with the public good and cares not if John Q. Chemist is making less money because of a faker. Compulsory licensing would eliminate most fakers and stabilize competition, accomplishing the aims of both the opposed groups. Illinois and Ohio are now considering proposed licensing laws, and it is reported that the Ohio A.C.S. sections have polled in favor of the Ohio measure. Since even the more abstruse sciences are more directly connected with public welfare than ever before, licensing is a matter of general interest to Techmen. Your views on unions and licensing are invited. Once again, public responsibility is the causative factor. Now, even more clearly, should the role of the Techman in society be visible, the human society of which you are a member and a prime mover.

E. M. K.

Monsanto Chemical Co.

Mice are placed in plastic boxes prior to studying the effects of exposure to pile radiation in the opening behind the protective balcony. Beneath the balcony live three "sentinel" rabbits

ISOTOPES FOR SALE

(*Continued from page 232*)

In conclusion, let us consider these comments on the availability of isotopes:

(1) A pile cannot make the extensive variety of radioisotopes producible with the cyclotron because the cyclotron makes use of a much greater diversity in energy and type of nuclear bombarding projectiles. However, the isotopes which can be made can be made on a much larger and less expensive scale.

(2) Although large numbers of radioisotopes are produced in abundance by the fission of uranium in the piles, their availability is limited by the difficulties encountered in isolating them.

(3) Most of the radioisotopes in greatest demand, such as C 14, S 35, and P 32, must be produced by the irradiation of materials foreign to the pile. The first piles were not designed for this purpose but more versatile ones are rapidly being constructed.

(4) Although a pile is a copious source of neutrons, it is not a limitless source. It is possible to load a pile for nonfission product radioisotope production only up to the limit at which so many neutrons are absorbed in the introduced material that the chain reaction ceases even though the control rods are withdrawn as far as is feasible. With available pile facilities, this limit does not permit the production of a sufficient quantity and quality of many isotopes to meet anticipated national demands.

(5) Technical problems involved in the irradiation of some materials have been, and will continue to be, responsible for delays in making certain isotopes available by routine irradiation. Examples of such problems are:

(*a*) proper canning of the material;

(*b*) careful purification to prevent loss of neutrons by absorption in impurities as well as undesirable radioactivity in the irradiated material;

(*c*) proper distribution of the material throughout

(*Continued on page 256*)

Mountain to Mohammed...

20th century version

Immovable as Mohammed's mountain is the orthodox power plant for a fair-sized city. Yet when power facilities were bombed out in Antwerp, Manila, Ghent, the power plant came to them...the mountain to Mohammed.

Appearing on short notice in the harbors of these devastated cities, floating central stations, boilered by B&W, each with a cargo of 30,000 kilowatts, brought relief months before stationary power plants could be rebuilt. At home, in other emergencies, they brought succor to Jacksonville ...to Pensacola...Vicksburg...

There are lots of problems in building boilers for central stations that hop about. The ships must be designed for passage through narrow locks and channels. Boiler weight and size must be pared down to make room for plenty of fuel...boiler efficiency kept high to make fuel last.

B&W built the boilers for the first floating power plant, has built others like them since. In this, as in its pioneering work in many fields, B&W illustrates its two major resources: the long experience of the past...its engineering vision, the courage to have new ideas.

B&W offers technical graduates excellent career opportunities in diversified fields of manufacturing, sales, engineering and research.

Send for the Booklet, "Your Career."

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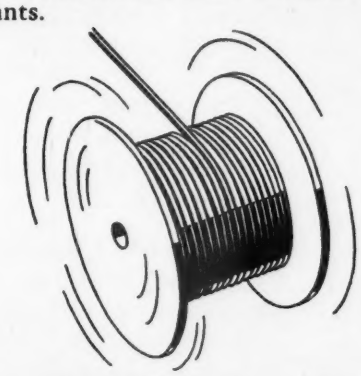
NUMBER 6 OF A SERIES

Newsworthy Notes for Engineers

What is CV?

CV is the answer to a tough problem. It stands for Continuous Vulcanization—a process developed by Western Electric engineers to speed-up and improve production of rubber-insulated telephone wire. It proved so efficient a process that more than thirty outside manufacturers have introduced CV into *their* plants.



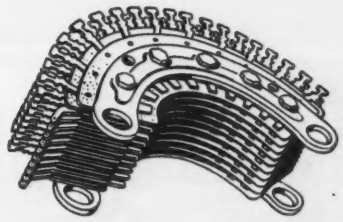
Under previous methods, the rubber compound was fed by hand into a forcing or tubing machine which extruded it upon the wire. The conductor with this unvulcanized covering was coiled in pans in a layer of powdered soapstone and sifted chalk, with each flat coil separated from its neighbor by another layer of soapstone and chalk. The insulated wire in the soapstone and pan was afterwards placed in a steam vulcanizing oven and cured for approximately 45 minutes. An additional reeling or coiling operation was required and the complete process took from one to three hours depending on the insulation wall thickness.

Now the continuous insulating and vulcanizing machine—developed and built by Western Electric engineers—does the whole job in one operation. Rubber compound and bare wire are both fed continuously into one end of the machine and then through steam at high pressure which cures the rubber insulation in approximately 7 seconds. The insulated wire is taken up on reels in continuous lengths up to 30,000 feet in a fraction of the time required under the old panning process.

Halving the steps on Step-by-Step

Simplifying production of over 1,000,000 Step-by-Step "banks" per year—for use in dial telephone exchanges—gave Western Electric engineers an interesting assignment.

One of several types of "banks" consists of 200 brass terminals, assembled in 10 levels, the terminals of each level accurately positioned on a crescent shaped phenol fibre insulator which separates them from the next level. The entire assembly occupies a space of but 4½" x 2½" x 1½". Initially, banks were made in ten steps: (1) spray varnish on phenol fibre strips; (2) punch insulators from these strips; (3) punch *individual* terminals from coils of brass sheet; (4) assemble a preliminary pileup, picking up each terminal by hand,—200,000,000 per year, and accurately positioning it on the varnished insulator; (5) bake; (6) compress to secure terminals to varnished surface of insulators and then dismantle preliminary pileup; (7) make final assembly, inserting additional insulators and spacers; (8) bake; (9) compress and tighten clamping screws; (10) cut off excess length of screws and line ream mounting holes.



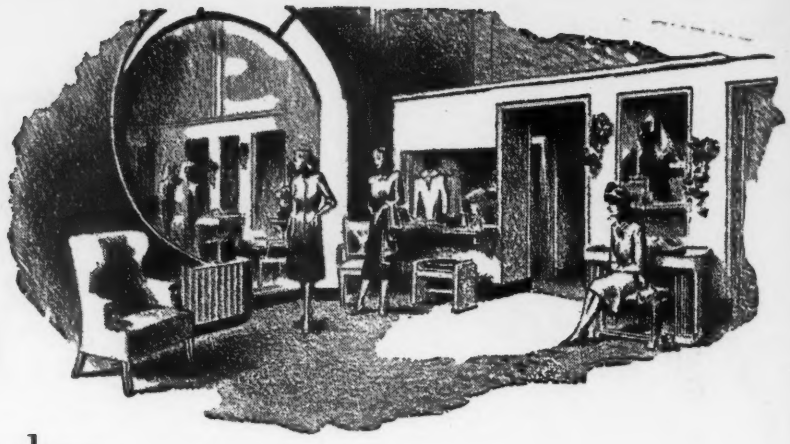
Western Electric engineers streamlined these ten steps into five: (1) punch insulators from *unvarnished* phenol fibre strips; (2) punch terminals, leaving them connected to each other, and wind into rolls; (3) automatically separate terminals from roll and eyelet to insulators in punch press equipped with dial feed tools; (4) make final bank assembly; (5) compress and tighten clamping screws.

Results—a 30% reduction in manufacturing cost, an improvement in quality, and more economical utilization of manpower and facilities.

Manufacturing telephone and radio apparatus for the Bell System is Western Electric's primary job. It calls for engineers of many kinds — electrical, mechanical, industrial, chemical, metallurgical — who devise and improve machines and processes for large scale production of highest quality communications equipment.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882



From an intimate dress shop to one of the tremendous Celanese textile plants

YORK makes climate-to-order

The huge turbo-compressor air conditioning systems that serve millions of cubic feet in the spinning rooms of the ultra-modern plant of Celanese Corporation of America at Celco, Va., are a far cry from the packaged air conditioner which cools the fashionable Lewis Gown Shop in Philadelphia.

But both are York Air Conditioning, and each does its job efficiently and economically. It takes one sort of climate to produce yarns for beautiful fabrics, and another sort to sell them, but both of these customers are happy since each has just what he asked for.

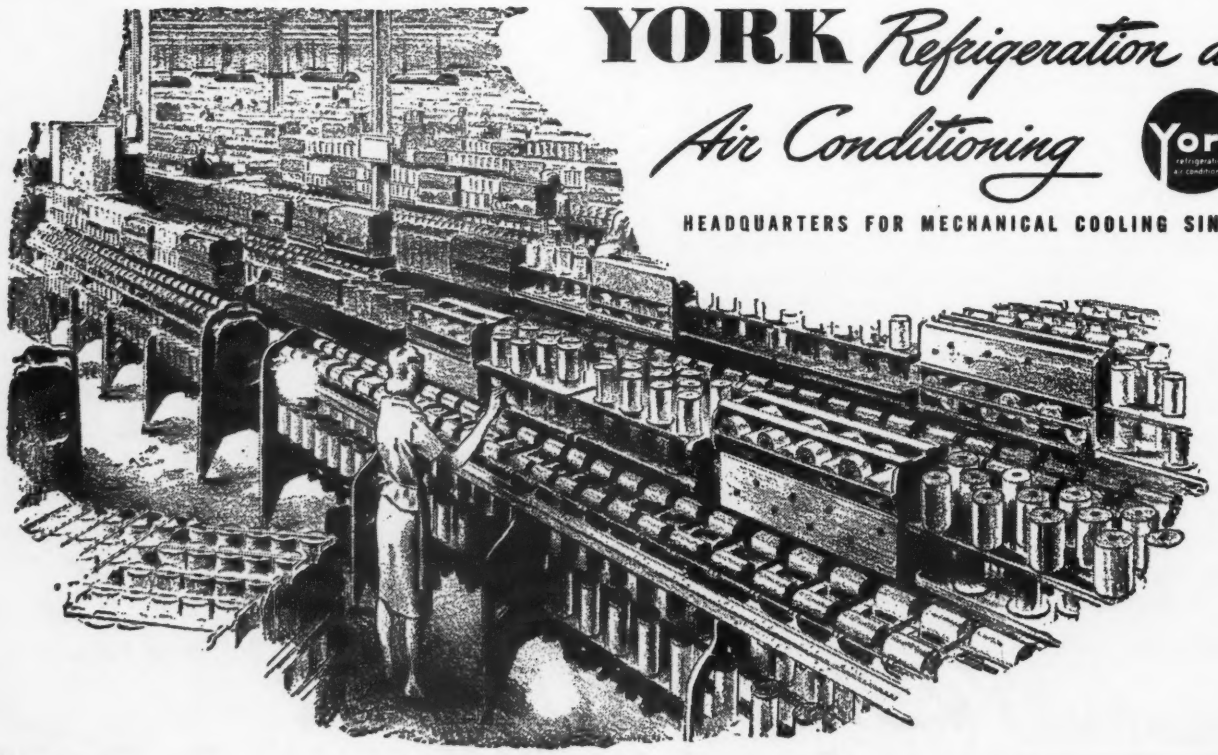
In your own business, whether your problems involve air conditioning or refrigeration, or both, three facts recommend your consideration of York:

1. The wide range of York equipment as to function, type and capacity assures selection of the right unit for the right place, no matter how large or how small.

2. The aggregate installed capacity of York mechanical cooling for commercial use exceeds that of any other manufacturer.

3. York research—already responsible for so many important advances—has been accelerated and intensified . . . an assurance of the lasting value of York equipment.

York Corporation, York, Penna.



YORK *Refrigeration and Air Conditioning*

York refrigeration air conditioning

HEADQUARTERS FOR MECHANICAL COOLING SINCE 1885

Because photography abolishes distance . . .

YOU'D THINK this quaint rural Guatemalan *campanario* with its century-old bells was right before you, wouldn't you? . . . that shows how photography abolishes distance.

Because of photography's unique ability to "bring" Latin America north . . . North America south . . . business and industry have been able to put it to many and varied uses. They use:

Motion pictures and slide films . . . to bring manufacturers closer to consumers, dealers, salesmen, employers.

Photo layout . . . to close the gap between drafting boards and production lines.

Instrument recording . . . to bring electrical or mechanical phenomena into the laboratory for analyzing and recording.

Document reproduction . . . to transfer complete and accurate information.

Photographic illustration . . . to make things seem real even though they're far away.

Photomicrography . . . to jump the barriers between the invisible and the visible.

This may give you an idea of some of the ways photography can be useful because of its ability to abolish distance. You'll find others in our booklet, "Functional Photography." Write for it. It is free.

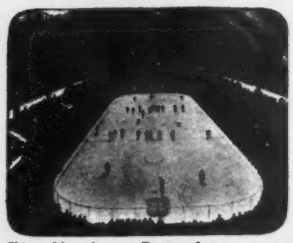
Eastman Kodak Company, Rochester 4, N. Y.

Functional Photography

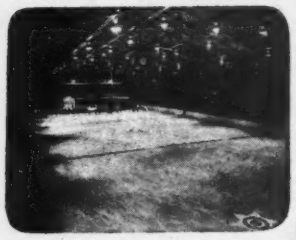
is advancing business and industrial technics

Kodak

Dorothy Lewis Skates on Ice Frozen with



The Hershey (Pa.) Arena seats 7,000, Uses Frick Refrigeration.



Two Rinks, 500 Miles North of Toronto, Both Use Frick Refrig.

FRICK Refrigeration

Star of the movie "Ice Capades of 1941", and now head of a troupe of skaters appearing in leading hotels, Miss Lewis uses a portable ice rink built by the Gartner Refrigeration Co., Frick Distributors at Minneapolis. ● And when she skates on permanent rinks, the chances are they're also operated with Frick Refrigeration—more than half of all those on this Continent are! ● If you want dependability with economy, insist on Frick Refrigerating, Ice-making and Air Conditioning Equipment.

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U.S.A.

COLOR TELEVISION

(*Continued from page 227*)

The receiver is equipped with three three-inch kinescopes which separately receive signals corresponding to the red, blue, and green pictures. The faces of these tubes are coated with phosphors which glow red, blue, and green, respectively. An optical system throws light from the Trinoscope, as this trio of kinescopes is called, upon a 15- by 20-inch screen. The pictures are said to be free of flicker, color fringes, and color breakup. The entire process is accomplished electronically, with no moving parts.

All the standards of RCA's color system are identical, insofar as possible, to those now used in black and white television. 525-line pictures are shown at a rate of 30 per second. The electrical characteristics of the green image, including the synchronizing pulses, are identical to those of present monochromatic television. This means that a present-day black-and-white receiver, with the addition of a cheap and easily installed radio-frequency converter, can be used to receive a color-broadcast, reproducing a monochromatic image identical to the green image a color receiver would produce. Furthermore, a color receiver can receive monochrome broadcasts. If this system were to go into general use, present black-and-white receivers would not become obsolete with the advance in the use of color, and color receivers would also be able to receive black-and-white programs. A single transmitter could supply the same programs to both types of receivers.

Both types of television have advantages and disadvantages. The salient advantages of CBS sequential color are the need for only one, rather than three, projection tubes in the receiver, and resultant lower probable costs; and the relative simplicity of transmission, only one video signal being used. Some of the advantages claimed by RCA for its system are: (1) complete compatibility with the present black-and-white commercial system, and resultant greater network flexibility (CBS's system is entirely incompatible with present black-and-white, due to different scanning rates and other factors); (2) all-electronic operation with no moving parts; (3) greater possible picture brightness for pictures of comparable size; (4) no color fringes, even around fast-moving objects; (5) no color breakup, as all colors are shown simultaneously; (6) complete freedom from flicker; (7) greater color fidelity; and (8) less bandwidth is required than is for the CBS system.

Which system, if either, will eventually become adopted on a commercial scale is still a matter of considerable doubt. CBS has petitioned the Federal Communications Commission to adopt CBS standards for color television. RCA, believing that its simultaneous system is superior to the sequential system, has fought to prevent the adoption of such standards, on the grounds that more engineering is necessary before any color television will be ready for the public. The FCC is conducting hearings on this subject. No decision has been reached at the time of this writing.

A television engineer prepares to transmit a Kodachrome slide through an RCA color television setup

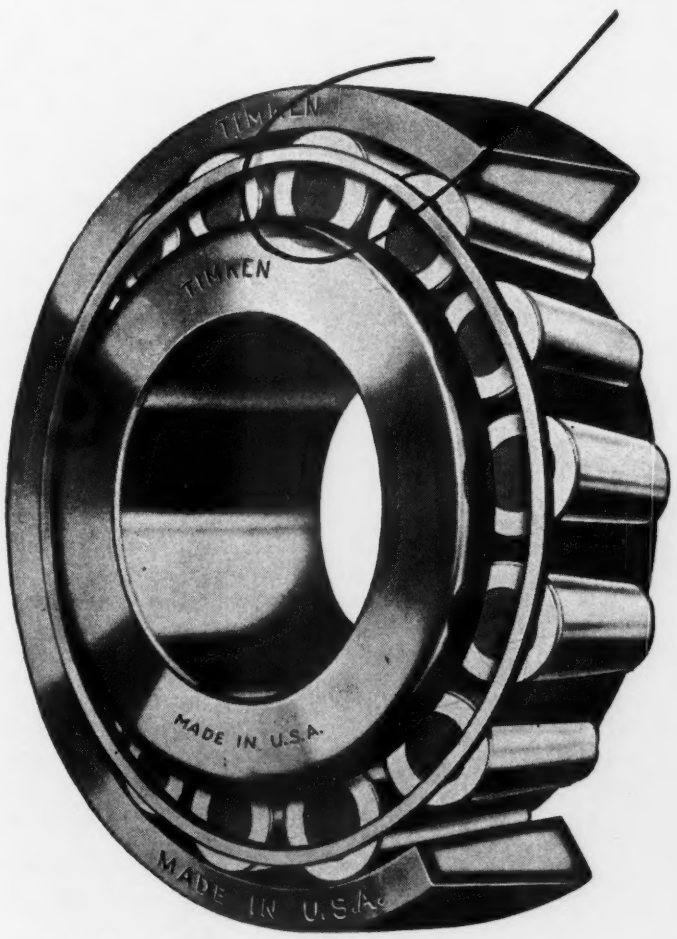
Radio Corporation of America

A BEARING QUIZ FOR STUDENT ENGINEERS

Do you know that over 90% of all modern bearing requirements can be met adequately with the Timken Tapered Roller Bearing? That in this one precision mechanism is contained a multiplicity of abilities which when fully appreciated and properly applied can overcome any bearing condition you ever may encounter?

Do you know that the Timken Roller Bearing is more than an anti-friction bearing; more than a radial load bearing? That it is an all-load bearing — can carry, all at once, radial loads, thrust loads, and any combination of them with full efficiency and certainty?

Do you know that the Timken Bearing was introduced nearly 50 years ago and has undergone constant engineering development and refinement ever since? That the Timken-developed process of Generated Unit Assembly produces true spherical (convex-concave) contact between the large ends of the rolls and the rib or flange of the cone thereby reducing friction and initial wear to a minimum; assuring correct alignment of the rolls with respect to the races; helping to distribute the loads evenly throughout the bearing; decreasing operating temperatures; producing quieter running; and last, but not least, assuring that when the bearing is properly mounted no further adjustment is required?



Do you know that the special alloy steel from which Timken Bearings are made was developed in our own metallurgical laboratories and is produced in our own steel plant? That the Timken Bearing is the only bearing manufactured under one roof from raw material to finished product?

Would you like to know more about the Timken Bearing, particularly how it can help you in your engineering career? Write us. The Timken Roller Bearing Company, Canton 6, Ohio.

LUFKIN "Peerless" Chrome Clad Steel Tapes

Rough, tough measuring work can't hurt the Lufkin "Peerless" Chrome Clad Steel Tape. Jet black markings are always easy to read. Sturdy steel line is covered with satin smooth chrome that resists rust and will not crack, chip, or peel. For free catalog write THE LUFKIN RULE CO., SAGINAW, MICH., New York City.

LUFKIN

FOR ACCURACY

YOUR SUPPER — MINUS WATER

(*Continued from page 236*)

three qualities are fairly similar functions of some of the more basic properties of the product: water content, density, pH value, fluorescence, and so on.

Considering the various optimum conditions as determined so far for the dehydration of milk, eggs, and orange juice, we find that they are proclaimed for a variety of drying methods and therefore cannot be considered mutually comparable, nor may they be the best operating conditions with some different set-up. However, they do serve as an approximate indication of the favorable range of temperature and humidity conditions for the drying process. In general, it is desirable to have the water content of the dried food as low as possible compatible with considerations of overall quality.

In the case of milk, the temperature at which drying occurs has not been found to be so critical as for other substances. Under spray drying conditions, to date probably the best all-round economical method of drying liquids, the temperature of the entering drying gases usually runs from 400 to 435° C.; but temperatures as high as 500° C. may be used. The milk is concentrated to about 40 per cent solids in preliminary treatment.

Optimum conditions for dehydrating eggs for the spray drying process are quoted variously from different sources. One indicates that the maximum temperature should be between 107 and 121° C. while another advises maximum temperatures from 150 to 160° C. These variations in the references demonstrate clearly that over the question of just what are the best drying conditions for any particular product, even in identical processes, there is still a wide area of disagreement.

In the dehydration of orange juice many difficulties are encountered, the product often polymerizing one way or another into a sticky mass rather than a dry powder. Ascorbic acid content decreases rapidly with even moderate heating conditions. Apparently the best method at present is a process in which water vapor is removed from orange juice concentrate under vacuum at low temperatures. These "low temperatures" probably run from 0 to 10° C.

Drying or dehydrating processes are many and varied, the methods employed being designed for the particular product treated and the peculiar economic factors involved. Basically, drying methods may be separated into two classifications — those designed for the handling and drying of solids as differentiated from those processes dealing with liquids.

But there still remain such a great many individual products with their associated problems, particularly under the former category, that there have been developed a vast number of different methods for treating them. A complete review and description of even a cross-section of the more typical of these is here impossible. However, a brief review and a few of those more significant in the field of food dehydration may well be discussed.

In the industrial field, particularly in the chemical industries, the drying process has an important place. Many chemicals must be carefully and completely dried before distribution — di-calcium phosphate, ammonium sulphate, chemicals used in all branches of our industrial world. Coal, itself, from which a number of our more important chemicals are extracted, must often be dried before shipment or processing, requiring large-capacity units where often the smallest economy in the drying process gives sizable savings.

The drying units themselves are of all sorts, a few batch units such as tray driers, but designed for most commercial, large-scale work to give continuous flow — the belt drier, drum drier, "Roto-Louvre," cyclone drier, and the many others.

Generally speaking, it may be said that the highest temperatures that can be used produce the most economical arrangement, provided that there are not other complications, and that it is advisable to separate as much water as possible by mechanical means first, before applying a heat for evaporation. This is why we look for the best *maximum* temperature conditions for our food drying and why we often find processes dealing with liquids concentrating them mechanically before the actual drying operation.

Since by far the great part of commercial drying is done by convection, one of the primary problems is to get as large an exposed surface area of the material to be dried as possible. This is where the drying of liquid products is often simpler than that of solids, since spray-drying and the associated methods for treating liquids are all designed to give an extremely large evaporation or drying surface by producing a very fine particle size.

An important factor in the drying process is the *relative humidity* of the gas stream used in the drying. The effect is similar to its importance in air-conditioning. It plays a more important part in what might be called low temperature drying than at the higher temperatures for the simple reason that above 200° F. the amount of moisture needed for saturation increases enormously.

The care which must be exercised in the choice of

(*Continued on page 254*)

Television today is clearer, sharper, and brighter—thanks to the improved kinescope, or picture tube, perfected at RCA Laboratories.

The Picture Tube that brought "life" to television

The screen on your home television table model receiver is the face of a large picture tube. And the skater you see on the face of the tube is the *identical twin* of the skater being televised.

Pioneering and research in RCA Laboratories led to the development of this tube which allows none of the original realism to be "lost in transit." It reproduces everything the television camera sees, shows you every detail, keeps the picture amazingly lifelike and real.

An RCA Victor television receiver brings you all the action, drama and excitement that you'd enjoy if you were at the event in person—and on top of that it's all brought to you in the comfort of your own home . . . you don't have to move from your favorite chair.

RCA Laboratories has made possible outstanding advances in every phase of television. And for television at its finest, be sure to select the receiver bearing the most famous name in television today—RCA Victor.

Radio Corporation of America, RCA Building, Radio City, New York 20. Listen to the RCA Victor Show, Sundays, 2:00 P. M., Eastern Standard Time, NBC Network.

Continue your education with pay—at RCA

Graduate Physicists: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects that offer unusual promise:

Development of acoustics and high-fidelity sound reproduction as applied to radio and television.

Development of optical systems for television receivers.

Investigation and development of high-vacuum techniques.

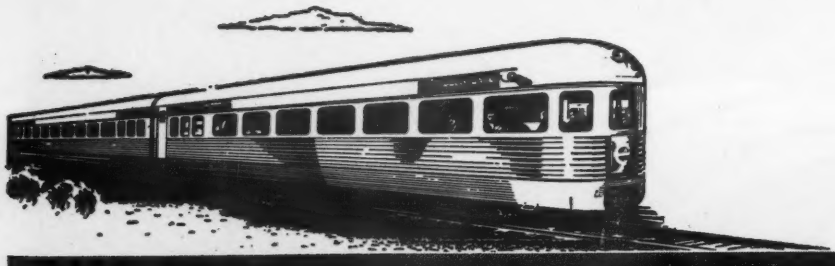
Development of microwave tubes, construction and operation.

Basic development of AM and FM broadcast transmitters, R-F induction heating, mobile communications, relay systems and commercial communication systems.

Write today to National Recruiting Div., RCA Victor, Camden, N. J.

Also many opportunities for Mechanical, Chemical, and Electrical Engineers.

RADIO CORPORATION of AMERICA



Forty Years of

Ten years ago the Burlington placed the present Denver Zephyrs and Twin Cities Zephyrs in service—four stainless steel, lightweight trains built by Budd.

Into those ten years these trains have crowded forty years of normal operation, for their daily mileage has been four times the national average.

Maintenance costs have been substantially below average despite high-speed schedules and continuous operation.

How trouble-free their performance has been is shown by their availability record—95.86% for the Denver Zephyrs, 97.03% for the Twin Cities Zephyrs.

Ability to give that kind of service is *built* into Budd trains. It starts with the material with which they are constructed—stainless steel, the strongest material suitable for railroad train construction.

Combined with Budd's fabricating methods it produces trains whose performance records prove they're the most economical equipment investment a railroad can make. The Budd Company, Railway Division, Philadelphia.

Train Service in TEN

TEN YEAR RECORD OF FOUR BURLINGTON ZEPHYRS

The Denver Zephyr (two trains) November, 1936—November, 1946
The Twin Cities Zephyr (two trains) December, 1936—December, 1946

Combined Mileage: Four trains, 13,690,919.

Daily Mileage: Denver Zephyrs, 1037.5 each; Twin Cities Zephyrs, 874 each.
Four times the national average.

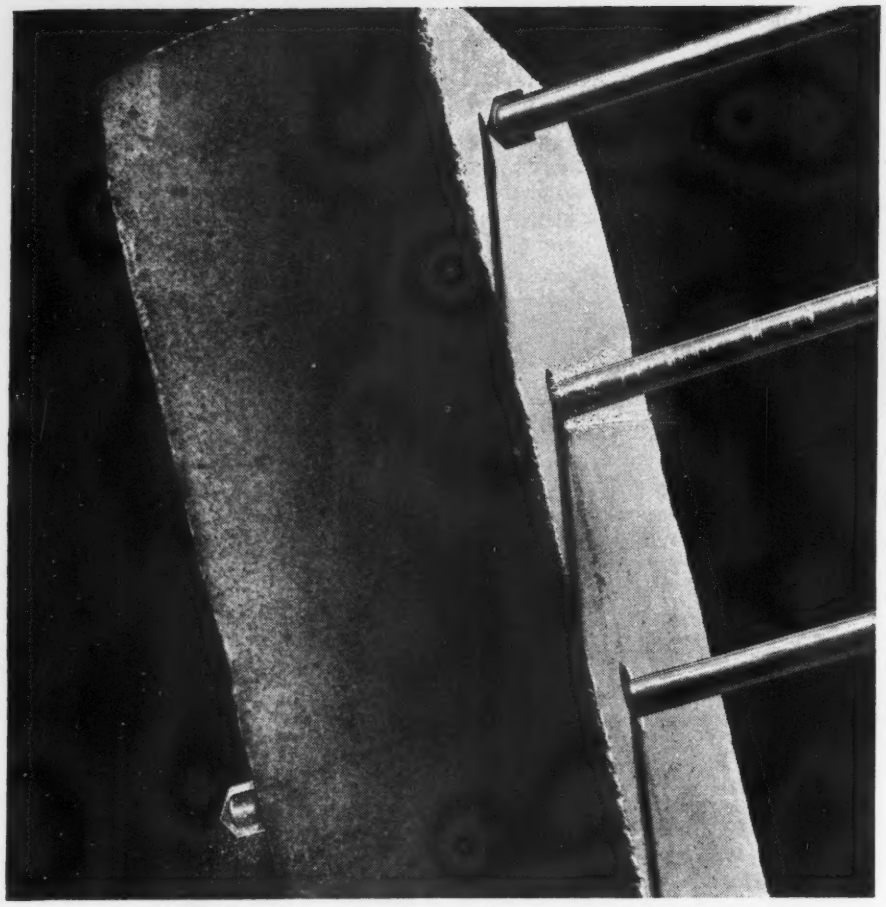
Average Speed: Denver Zephyrs, 65 mph; Twin Cities Zephyrs, 63 mph.

Daily Operation: Denver Zephyrs, 16 hours out of every 24. Twin Cities Zephyrs, 14 hours out of every 24.

Usage: Double the national average hours per day.

Maintenance: Costs below average per mile, per run, per day, per year!

Budd



Now the toughest masonry can be rotary drilled almost as easily as a knife cuts cheese! The secret is found in the drill tip. It is made of an amazing new metal of many uses —*the hardest metal made by man.* This metal is Carboloy Cemented Carbide.

Why tough masonry turns to cheese

MASONRY drills are just one example of how Carboloy Cemented Carbide boosts production while cutting costs. They drill holes *four times faster* through every kind of masonry —and they stay sharp as much as *fifty times longer.*

As a tool, die or wear-resistant machine part, Carboloy has earned a reputation among authorities as *one of the ten most important developments of the past decade.* And here's why:

1. **Carboloy commonly triples the output of both men and machines,**
2. **Cuts, forms or draws the toughest, most abrasive modern alloys with accuracy and speed previously unknown, and**
3. **Regularly increases the quality of products.**

A workhorse of industry, cemented carbides are removing more metal at higher speeds than any other material.

Accept This Challenge

We'll give odds of 10 to 1 that Carboloy engineers can help you to achieve higher quality for your products at lower cost. It's high time to investigate.

Carboloy Company, Inc., Detroit 32, Mich.

Send today for this free leaflet SN-225 on cost-cutting Carboloy masonry drills.

CARBOLOY
(TRADE MARK) • CEMENTED CARBIDE

The Hardest Metal Made by Man

YOUR SUPPER

(*Continued from page 250*)

conditions and methods used in dehydrating foods has its counterpart in other fields of commercial drying. Some materials lend themselves more readily to one type of drying than to another. Then again, some materials must be handled so that the crystals or particle sizes will not be broken or scratched. Heat sensitivity of a particular material must be given special attention so that the product will not be ruined in the drying process.

In the particular field of food dehydration, solid foods, vegetables, fruits, are often dried in cross-flow tunnel units similar to industrial types — using an air stream heated by fuel oil or some similar source of energy. Recent attempts have been made to dry solid foods by dielectric methods,* but with no outstanding results as yet.

Drying liquid foods usually involves the spray-drying technique with spray nozzles, and cyclone-type apparatus, though some concentrated fluids are dried on a revolving drum-type apparatus, being spread on in a film and scraped off in dry flakes. The spray-drying methods have the undoubted advantage of a large available drying surface and as a consequence usually represent a saving in plant space for a given drying capacity.

Milk is dehydrated practically universally by spray-drying the concentrated liquid at high temperatures for a short time of contact.

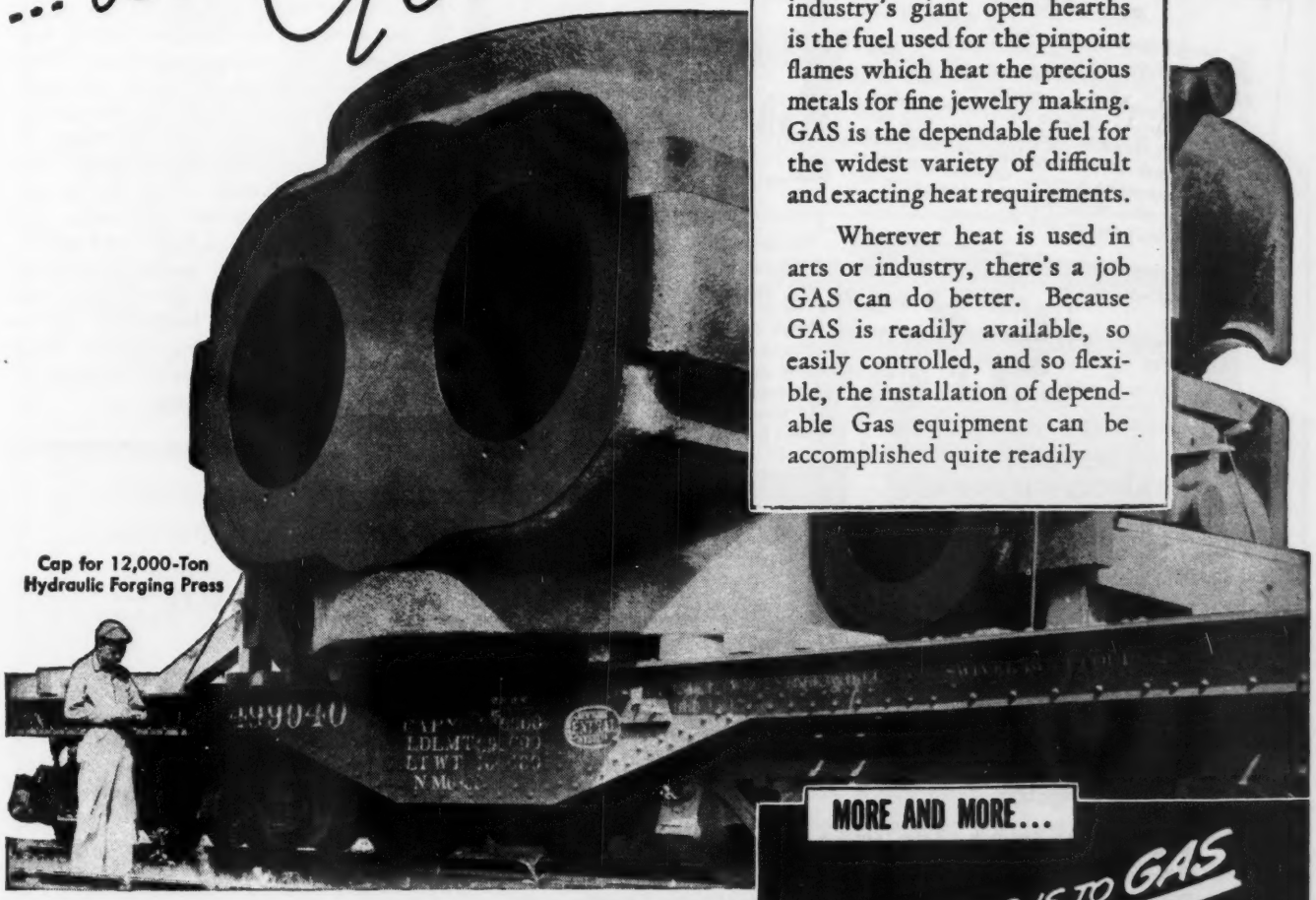
Drying eggs is a simple process. The homogenized liquid egg is strained and piped through a machine which pumps it under high pressure through tiny nozzles in a mist-like spray into a large, heated drying chamber. As the sprayed liquid strikes the heated air it is quickly transformed into a dry yellow flaky powder. In addition to the spray-drying method described, eggs are sometimes dehydrated in tray, belt, or drum units; but these processes are subject to the disadvantages listed above and generally inferior economically, and sometimes in quality of final product as well.

Orange juice has been dried on vacuum drum units without refrigeration and on belt driers, but the results have invariably been unsatisfactory. The low-temperature sublimation drying mentioned above is more expensive but gives better results. The low temperatures ap-

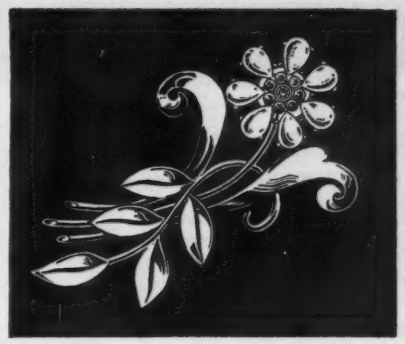
(*Continued on page 256*)

* See Lee, H. L., THE TECH ENGINEERING NEWS, Vol. 27, February, 1946.

FOR PENNYWEIGHTS OR HEAVYWEIGHTS ... use GAS



Cap for 12,000-Ton Hydraulic Forging Press



From jeweler's torch to open hearth there's no heating job too large, too small, too difficult for GAS.

When Mesta Machine Company, Pittsburgh, Pa. poured the world's largest steel casting, weighing 600,000 pounds, the charges in four Gas-fired open hearth furnaces were ready simultaneously, demonstrating the complete controllability of GAS.

That same GAS which fires industry's giant open hearths is the fuel used for the pinpoint flames which heat the precious metals for fine jewelry making. GAS is the dependable fuel for the widest variety of difficult and exacting heat requirements.

Wherever heat is used in arts or industry, there's a job GAS can do better. Because GAS is readily available, so easily controlled, and so flexible, the installation of dependable Gas equipment can be accomplished quite readily

MORE AND MORE...

THE TREND IS TO GAS

FOR ALL INDUSTRIAL HEATING

AMERICAN GAS ASSOCIATION

420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

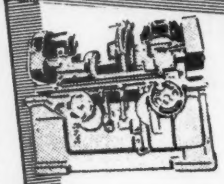
Here's What NORTON Makes . . .

ABRASIVE PRODUCTS

Grinding wheels ranging from tiny internals 3/16" x 3/16" to gigantic ten-ton pulpstones — wheels of Alundum*, Crystolon* and diamond abrasives, of many different bonds; abrasive bricks, sticks, hones and segments; mounted points and mounted wheels; abrasive grain for polishing, lapping and tumbling.

GRINDING and LAPPING MACHINES

Norton cylindrical grinders range from the neat, compact 4 x 12" Type C to the gigantic 36 x 816" Type D and include special types for grinding crankshafts, camshafts, rolls and car wheels. Norton surface grinders are available in three sizes, 6", 10", and 12". There are three Norton Tool and Cutter Grinders and the Norton Buraway. Lapping machines for flat and cylindrical work including crankshafts and camshafts range from the small 10-U to the large Hyprolap*.

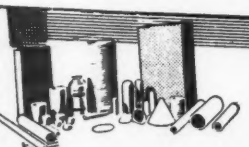


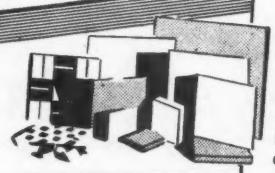
NORBIDE*

"The hardest material made by man for commercial use"— that is NORBIDE*, the trade name for Norton Boron Carbide. It is serving industry in three forms: (1) Norbide Abrasive for grinding and lapping carbide tools, and for lapidary work; (2) Norbide Molded Shapes for pressure blast nozzles and for plug, ring and other types of gages; (3) Norbide Metallurgical Compound for improving the hardness and cutting ability of tool steels and as a deoxidizing agent.

REFRACTORIES

The terrific heat of the electric furnaces which produce Alundum and Crystolon abrasives also gives these materials valuable refractory properties — properties which are made use of in a complete line of Norton refractory grain, cements, bricks, plates, tiles and other shapes for metal melting and heat treating, for enameling furnaces, ceramic kilns, boiler furnaces; also refractory laboratory ware for ignition, incineration and filtration.





NORTON FLOORS

The hardness, toughness and abrasive properties of Alundum abrasive are made use of in NORTON FLOORS — Alundum Stair and Floor Tile, Alundum Ceramic Mosaic Tile and Alundum Aggregate for terrazzo and cement floors. They are for use in public and commercial buildings to provide an extremely wear-resisting and permanently non-slip surface (wet or dry) for floors and stairs.

OILSTONES and COATED ABRASIVES

Sharpening stones in sizes and shapes to meet every need of the industrial worker, the farmer and the home craftsman; and abrasive paper and cloth in a wide variety of coatings and types for both industry and the home mechanic are available through Behr-Manning Corp., Troy, New York, Division of Norton Company.

* REG. U. S. PAT. OFF.

Informative literature on any or all Norton products gladly sent on request—no obligation.

NORTON COMPANY, WORCESTER 6, MASS.

Offices or Warehouses in Nine Cities • Branch Plants in Six Countries • Distributors in 200 Cities of the United States and Foreign Countries

NORTON

YOUR SUPPER

(*Continued from page 254*)

parently enable the solids to retain their fiber structure without chemical deterioration.

As can be seen from the present cost figures and product quality, the processes and methods now used in the food dehydrating industry contain many deficiencies which are often a great handicap to manufacturers of dehydrated products in competition with foods processed in other manners. But with the recognition of this condition and the increased amount of work in the research laboratories of food driers, the dehydration industry may one day dominate a food-processing industry designed to meet a world-wide demand.

ISOTOPES FOR SALE

(*Continued from page 244*)

the pile to prevent local overheating or undesirable regulation characteristics of the pile.

Isotopes are now available to prospective users from the Clinton Laboratories at Oak Ridge. Probably the most famous use of radioisotopes is the treatment of leukemia with radiophosphorus. Since pure compounds can now be made with a definite localized action in the body, it is to be expected that the medical use of radioisotopes will rise tremendously when the requisite techniques of operation and therapy have been fully worked out. But perhaps the most interesting observation of all is that death in the form of the atom bomb and life in the guise of radioisotopes come from exactly the same project — Oak Ridge, Tennessee!

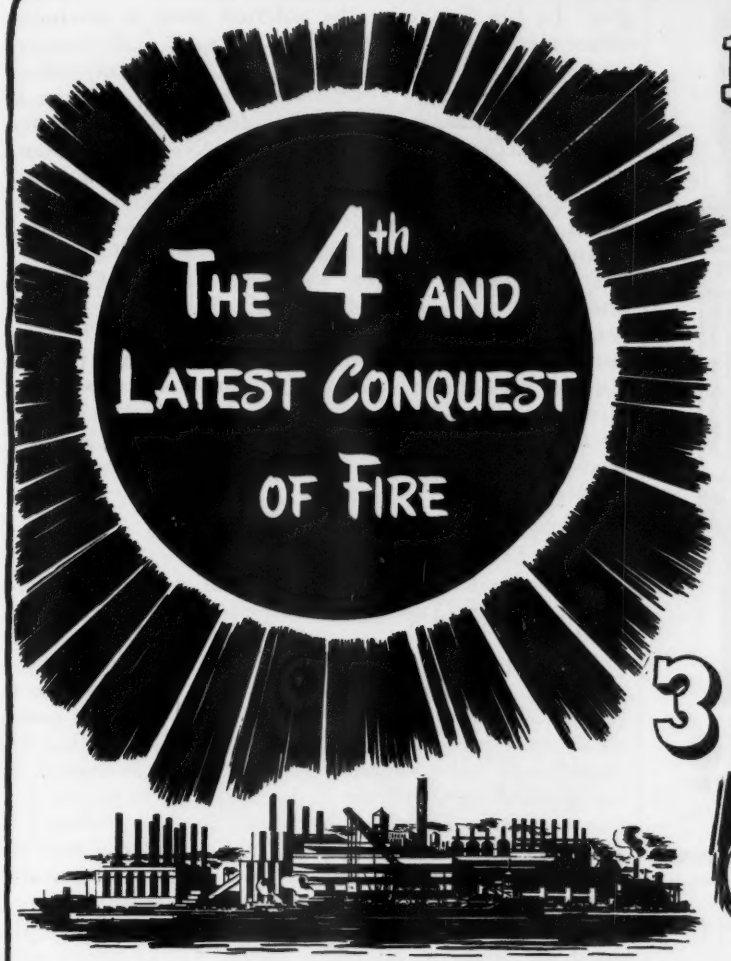
Next Month—

THE STORY OF

"WMIT . . ."

Don't Miss It!

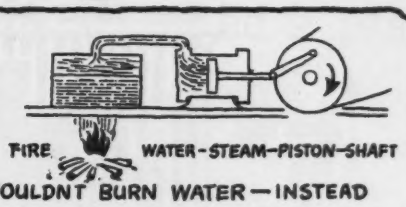
THE 4th AND LATEST CONQUEST OF FIRE



1 FIRE··

THE DIFFICULT THING ABOUT FIRE IS THAT IT'S HOT! IT BURNS! BUT PRIMITIVE MAN LEARNED TO USE THIS HEAT TO WARM HIMSELF···COOK··· HARDEN CLAY··· SOFTEN AND MELT METAL.

2



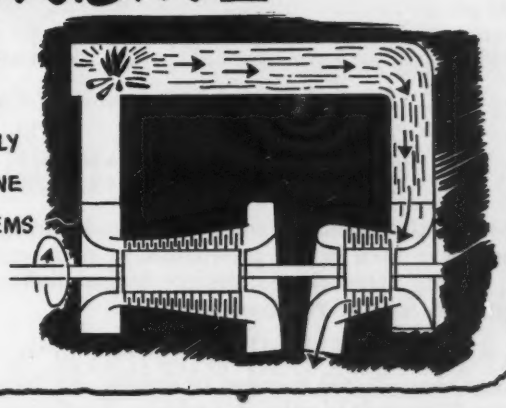
FIRE COULDNT BURN WATER—INSTEAD IT CHANGED IT TO STEAM. SO MAN HARNESSED STEAM, USING FIRE INDIRECTLY TO PUSH A PISTON—TURN A WHEEL AND SHAFT....

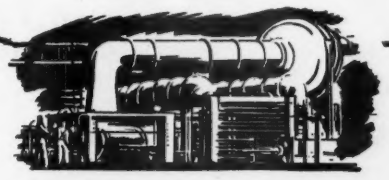
3 FIRE-PISTON-SHAFT··

INVENTION OF THE INTERNAL COMBUSTION ENGINE ELIMINATED STEAM AS A LINK···BROUGHT FIRE CLOSER TO THE CRANK··· BUT THE FRICTION OF RECIPROCATING MACHINERY STILL LOSES POWER··· CAUSES WEAR.

4 THE GAS TURBINE··

NOW, IN THE GAS TURBINE, FIRE IS APPLIED DIRECT TO THE SHAFT. A COMPRESSOR SUPPLIES AIR TO THE COMBUSTION CHAMBER. FUEL BURNER HEATS AIR, GREATLY INCREASING ITS VOLUME. HEATED AIR RUSHES THROUGH TURBINE AND TURNS SHAFT. SOUNDS SIMPLE BUT MANY TOUGH PROBLEMS OF DESIGN AND METALLURGY HAD TO BE SOLVED TO MAKE IT PRACTICAL.....





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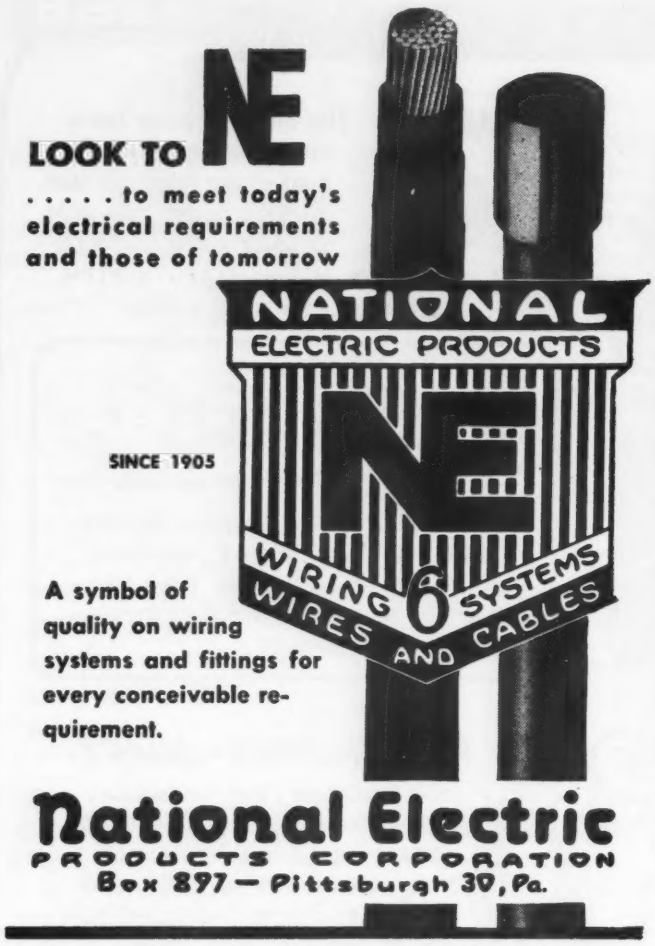
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THE HYDRIDES

(*Continued from page 229*)

CaH_2

Calcium hydride is now being produced in larger quantities than any other hydride. The magnitude of this production is indicated in the following table of the yearly production of Metal Hydrides, Inc. In 1944 and 1945 the company produced half of the national amount.

Year	*Pounds of* CaH_2
1940	214
1944	681,816
1945	316,632

Most of the calcium hydride produced during the war years was used in the production of hydrogen for use in, among other things, meteorological balloons. The equation for the reaction is:

$$CaH_2+2H_2O \rightarrow Ca(OH)_2+2H_2$$

More than 20,000 liters of hydrogen can be produced from 40 pounds of calcium hydride. Furthermore, since the hydrogen is produced rapidly, smoothly, and under high pressure, this process may well be used in such ways as the pumping of rocket fuels. Since this hydrogen is of greater purity than that obtained from the reaction of acid with metals such as zinc, calcium hydride is frequently used in the laboratory. Although the end of the war removed most of the demand for calcium hydride in the production of hydrogen gas, it is expected that even greater quantities will be produced in the next few years because of the expected increase in demand for calcium hydride to be used in other processes.

Calcium hydride can be produced either by the direct interaction of pure calcium with pure hydrogen or by the reaction of lime with magnesium and hydrogen. In the first case the calcium used is produced either electrolytically or by high vacuum, high temperature distillation of metallic calcium from a mixture of lime and secondary aluminum. This pure calcium is placed in a furnace and heated at 400° C. for twenty minutes, after which time it is cooled for two hours under an atmosphere of hydrogen. About four hours are required for the production of a two-hundred-pound batch. The grey-white, crystalline calcium hydride produced in this way is of 98 per cent purity, the impurities being chiefly oxygen, with traces of Mg, C, Si, Fe, and Ni. It can be ground in dry air without any danger, provided that no alkali hydrides are present. The chief trouble with this method of production is that the calcium hydride produced costs about one dollar per pound. Recently a much cheaper method of production has been devised; magnesium is briquetted with lime and heated to 400° C. in an atmosphere of hydrogen. The equation for the reaction is:

$$CaO+Mg+H_2 \rightarrow MgO+CaH_2$$

Calcium hydride mass-produced in this way would cost only twenty-five cents a pound, but it would contain 60 per cent MgO unless some method of separation can be devised.

Large quantities of calcium hydride are used in the reduction of refractory metal oxides. The reaction is carried out by heating calcium hydride and the metal oxide to several hundred degrees, and then letting the mass cool — in a vacuum if a pure metal is desired, in hydrogen if the hydride is desired, and in nitrogen if the nitride is desired. The calcium oxide produced is leached out with dilute HCl or HAc. Often a mixture of refractory oxides is used so that a true alloy suitable for immediate use in powder metallurgy will be formed. Among the products of these reactions are Zr and ZrH_2, used as "getters" in radio tubes; Ti-Cu alloys with tensile strengths of 100,000 psi; Cr-steel alloys; Zr-Cu alloys with high tensile strength and high electrical conductivity; and titanium nitrides and carbides for use as cutting edges on tools.

Calcium hydride is being used more and more in organic chemistry. At temperatures below 300° C. it is a relatively weak reducing agent well suited for use in such reductions as benzaldehyde to benzyl alcohol, and benzylidene acetone to 4-phenyl-2-butanone. Calcium hydride is preferred to calcium or sodium metal in these cases because of the ease with which the reactions can be controlled. Above 350° C. calcium hydride becomes a powerful reducing agent, but not much work has been done as yet by organic chemists with calcium hydride at such temperatures.

Calcium hydride is a very effective drying agent, as is shown in the following table:

Drying Agent	Mg *of* H_2O *remaining/liter dried air*
$CaCl_2$	0.14
CaO	0.2
Alumina	0.003
P_2O_5	0.00002
Na	$>1\times10^{-23}$
CaH_2	$<1\times10^{-23}$

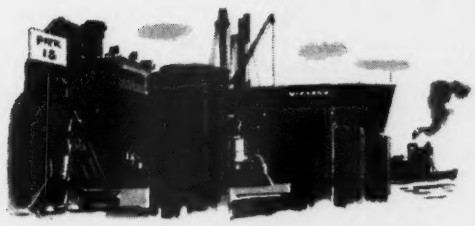
The reaction is:

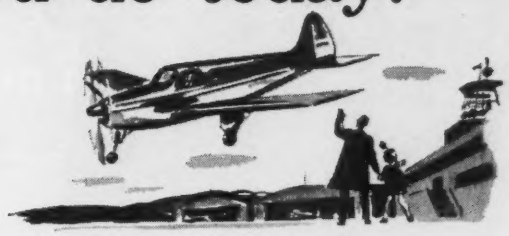
$$CaH_2+2H_2O \rightarrow Ca(OH)_2+2H_2$$

A major advantage in the use of calcium hydride as a drying agent is that it remains efficient over a wide tem-

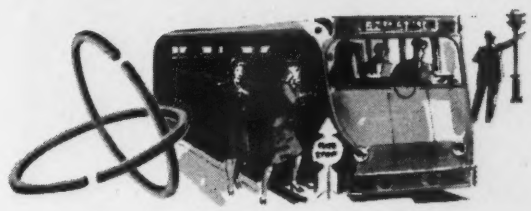
(*Continued on page 260*)

What did you do today?





If you visited the waterfront[1] . . . . . or watched a plane[2]



. . . or turned on the radio[3] . . . . . or boarded a bus[4] . . . .

. . . saw a freight car[5] . . . . . or went to the dentist[6] . . . .

. . . lighted a candle[7] . . . . . or bought a necktie[8] . . . . . .

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you saw a Koppers product in use[9]

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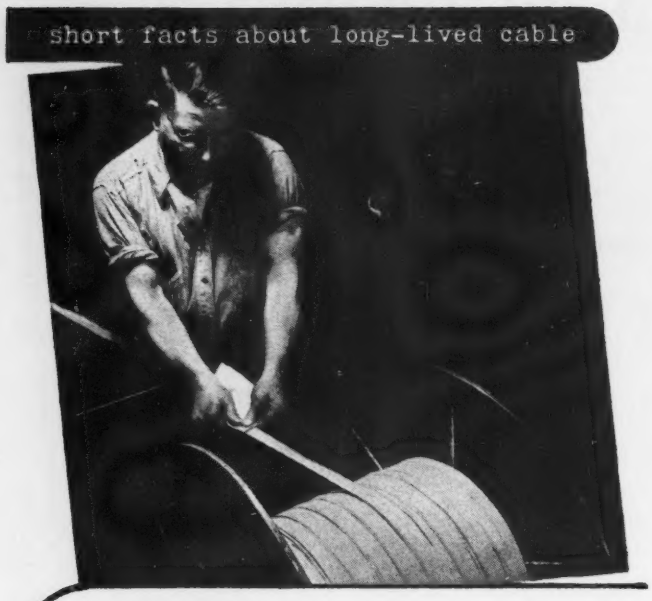

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THE HYDRIDES

(*Continued from page 258*)

perature range. Furthermore it removes not only water but also such impurities as carbon dioxide, acids, aldehydes, mercaptanes, and methyl ketones from liquids such as transformer oils and dry-cleaning solvents. In general, calcium hydride can be used to dry any substances — plastics, oils, Grignard ether, esters, hydrocarbons — which are neither acidic nor easily condensable. It should be apparent, however, that adequate ventilation must be provided if large quantities of calcium hydride are used to remove gross amounts of water; therefore calcium hydride is used primarily as a super-drying agent.

Aldol condensations may be performed with calcium hydride as the condensing agent. A typical equation would be:

$$RCOCH_3 + RCOCH_3 \xrightarrow{MH} RCH(OH)CH_2COR + MOCH_3$$

Calcium hydride will not only promote numerous other self-condensations such as those of aldehydes with esters, but also cause the metallation of acetoacetic ester and bring about Claisen condensations.

NaH

Sodium hydride is not being produced in anywhere near as great quantities as calcium hydride, but the gap is closing rapidly. Sodium hydride is produced by the direct interaction of sodium and hydrogen, the sodium being dispersed by some such agents as fluorene or fatty acid soaps. As yet, this process is not commercially practicable.

In bringing about condensations without reduction, sodium hydride reacts much like sodium alkoxides; for this reason it is frequently used to bring about certain Claisen condensations. Furthermore, sodium hydride will dissolve in sodium hydroxide until it is 23 per cent by weight of the solution; dilute (1/3 per cent) solutions of this nature are often quite effective in "descaling" metals by removing the surface layer of oxide. Sodium hydride is also frequently used in the preparation of sodium derivatives of alcohols and other active hydrogen compounds. In general, it might well be said that the uses of sodium hydride parallel those of calcium hydride.

Complex Hydrides

Recently a number of complex hydrides have been discovered: sodium and lithium boro-hydrides and di-boro-hydrides ($LiBH_4 \cdot LiB_2H_6$), gallium di-boro-hydride, dialkyl-gallium-boro-hydrides, silicon hydrides (silanes), alkyl silicon hydrides, aluminum boro-hydride, and lithium aluminum hydride, to mention a few. Perhaps the most interesting one at present is lithium aluminum hydride, which is a very powerful reducing agent that will produce many useful new substances.

Lithium aluminum hydrides can be prepared by the following reaction:

$$4LiH + AlCl_3 \rightarrow LiAlH_4 + 3LiCl$$

One of the principal uses of lithium aluminum hydride is in the preparation of the hydrides of groups II, III, IV, and V of the periodic table according to the following general equation:

$$4MCl_x + xLiAlH_4 \xrightarrow{\text{(ether)}} 4MH_x + xLiCl + xAlCl_3$$

It should be realized that $AlCl_3$ can be used in the same general way. Diborane (B_2H_6) can be prepared in the same general way as the MH_x in the above equation, although the exact conditions are restricted in formation. The following two equations should give an idea of the many kinds of variations which can be made on the basic reaction:

$$LiAlH_4 + SiEtCl_3 \xrightarrow{\text{(ether)}} SiEtH_3 + LiCl + AlCl_3$$

$$LiAlH_4 + Zn(Me)_2 \xrightarrow{\text{(ether)}} ZnH_2 + LiAl(Me)_2H_2 + Al(Me)_3$$

Lithium aluminum hydride is always used with ether as solvent and catalyst.

Lithium aluminum hydride is also an excellent reducing agent for organic reactions. Some of the more important reactions involving lithium aluminum hydride are:

acids, aldehydes, ketones, esters, organic acid chlorides $\xrightarrow{LiAlH_4}$ alcohols

crotonaldehyde → crotyl alcohol

allyl bromide → propene (double bonds not reduced)

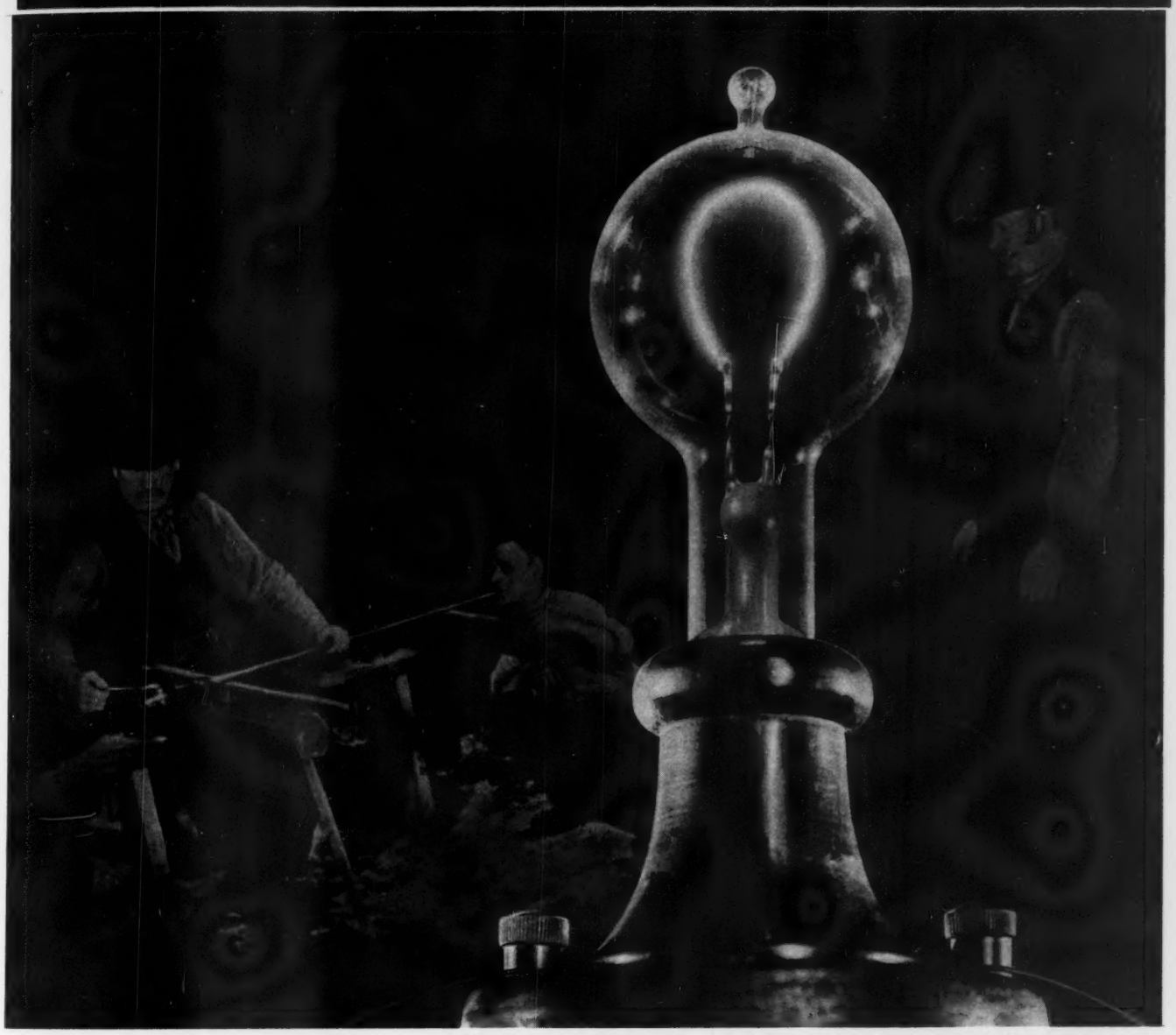
carbon dioxide → formaldehyde

$$2CO_2 + LiAlH_4 \rightarrow 2HCHO + LiAlO_2$$

The last reaction is very significant since it, in effect, duplicates photosynthesis.

It is readily seen that there are excellent opportunities for the employment of hydrides even on the basis of known reactions — and the field of research on these compounds is barely touched. Therefore the future of hydrides depends perhaps more on research than that of any other group of compounds — what a bright future it can be!

We blew a bubble for a man named Edison . . .



SIXTY-EIGHT years ago a stranger got off the train at Corning, New York, and asked the station agent to direct him to Corning Glass Works.

He had been sent by Thomas A. Edison to see if Corning could succeed where others had failed, in making a glass bulb to surround the filament of his new electric lamp.

Producing the thin bubble of glass for Mr. Edison's first lamp was an early milestone in Corning research. If he had lived until his hundredth anniversary this year, Edison would see machines developed by Corning turning out hundreds of modern bulbs every minute.

Altogether Corning has contributed in countless ways to science and industry and the comfort of living. Casting the 200 inch telescope disc, which this year will bring our civilization a billion "light years" closer to the secrets of the universe, is a Corning achievment.

So are the colored signals that guide trains through the night in safety. So are the miles and miles of America's neon tubing, and the miles of acid resisting glass piping in food and chemical plants. So are gleaming Pyrex baking dishes and amazing Pyrex Flameware for top-of-stove cooking.

The very thermometer the doctor puts in your mouth is quite likely made of Corning tubing. Today Corning research's main task is helping manufacturers make better products at lower cost. After graduation, this research may help you get ahead faster. Write the name Corning in your memory book now and call on us when you need help. Corning Glass Works, Corning, N.Y.

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Answers to last month's

Can You Do It?

Problem 1: Call the three wise men A, B, and C. A reason as follows: "B must think his face is clean, since he is laughing. Thinking that, if my face were clean also, B would be astonished at C's laughter, for C would have nothing to laugh at. However, since B shows no signs of astonishment he must think that C is laughing at me — and, thus, my face is black."

Problem 2: To anyone who knows anything at all about probability, this one is a little foolish. Past occurrences have no bearing on future happenings. Thus, the probability that I will toss another head on my next try is merely one out of two, or fifty per cent.

Problem 3: This problem is solved most easily by simply working it backwards. If you do so, you will find that the three men started with $21, $39, and $12 respectively.

Problem 4:

Vessel	*Amount of Gasoline in Each can, by Stages*							
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
8 gallon can	8	3	3	6	6	1	1	4
5 gallon can	0	5	2	2	0	5	4	4
3 gallon can	0	0	3	0	2	2	3	0

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DEPENDABLE COMMUNICATION AND NAVIGATION EQUIPMENT

"... AND IN THE WAKE OF GIANTS ..."

(*Continued from page 233*)

plausible explanation for another of nature's mysteries — that of the origin of meteors. In many instances, comets of known periods, that have appeared regularly for many centuries, have suddenly failed to return. On the day and year that they are due, the earth is visited with a display of shooting stars, or meteors. Some of these fall to the earth, and are called meteorites. If the orbits of comets are calculated and plotted, it is found that every year, as the earth crosses one of these orbits, there is a slight meteor shower. These showers become more intense when the earth's passage across a cometary orbit coincides with the time that the comet itself was due to arrive. This seems to indicate that meteors are spread out in an elliptical ring over the entire orbit of a disintegrated comet. On April 20, for instance, the earth will pass through the orbit of Comet L 1861, a long period comet (four hundred and fifteen years). There will be a display of shooting stars that night, which is called the Lyrid meteor swarm. And again on May 4, the earth will pass through the orbit of Halley's comet and will receive the meteor swarm called the Eta Aquarids. During a shower, the effects of perspective make the parallel lines of meteor fall seem to radiate from a point in the sky. If the point is located in a constellation, the meteor swarm is named after that constellation. Thus the Leonids of November 14–15 are named after Leo the Lion, the Perseids come from Perseus, etc. Although there are evidences of meteor swarms not coinciding with known cometary orbits, the vast majority of evidence seems to

(*Continued on page 264*)

Du Pont *Digest*

Items of Interest to Students of Science and Engineering

The Synthesis of Nylon

Chemists of original nylon research team honor memory of Dr. Carothers at the dedication. They are: J. W. Hill, Ph. D., M. I. T. '28; H. B. Dykstra, Ph. D. Ohio State '27; G. J. Berchet, Ph. D. Colorado '29; J. E, Kirby, Ph. D. Iowa State '29; E. W. Spanagel, Ph. D. McGill '33; D. D. Coffman, Ph. D. Illinois '30; and F. J. Van Natta, Ph. D. Michigan '28. Dr. Carothers received his Ph. D. from Illinois in 1924.

Dr. Wallace Hume Carothers

1896-1937, was the first organic chemist in industry to be elected to the National Academy of Sciences. During his short scientific career he made contributions that have greatly enriched American life.

Recently the Nylon Research Laboratory near Wilmington was dedicated as "The Carothers Research Laboratory," in honor of the late Wallace Hume Carothers and his classical researches on the structure of polymers, the mechanism of polymerization, and the invention of nylon.

In 1928, a group of chemists under Carothers began a study of polycondensation which led eventually to the discovery of nylon. The project was part of a program of fundamental research to discover scientific facts which might be of eventual value in laying a foundation for applied research.

As the first point of attack, they chose the condensation of dibasic acids with glycols and reaction materials which would preclude the formation of rings. They obtained linear polymers of molecular weights between 2300 and 5000.

Molecular Weights Increased

After two years, a significant advance in linear polymer preparation was achieved. Through the use of the molecular still, it was possible to obtain materials of molecular weights between 10,000 and 25,000, which, when molten, could be drawn into filaments.

More important, the cooled superpolyester filaments could be further drawn into fibers several times their original length and thereby acquired luster, tensile strength, elasticity, pliability, and toughness much greater than the initial polymer. In contrast with ordinary textile fibers, their tensile strength was unchanged by wetting.

The striking properties of the fibers aroused the hope of finding a commercial fiber from some type of linear superpolymer. Investigation showed, however, that fibers from the polyesters were too-low melting and too soluble for textile purposes. Mixed polyester-polyamides were also not of interest in this category.

Research on Fibers

The possibility of a commercial fiber development seemed remote, but the intuition that frequently accompanies research genius prevailed, and Carothers was encouraged to direct his research on superpolymers specifically toward spinnable fibers. A polyamide from 9-aminonanoic acid gave a fiber of 195°C. melting point, equal in strength to silk, and clearly indicated the possibility of obtaining a material for fibers of commercial utility.

In 1935, the superpolymer from hexamethylene diamine and adipic acid was first synthesized. It melted at 263°C., was insoluble in common solvents, tough, elastic and had the best balance of properties and manufacturing costs of any of the polyamides then known.

A third period of research covered commercial development. The task was enormous, and to reduce to a minimum the "time between the test tube and the counter" a large force of some of the most competent chemists, physicists, chemical and mechanical engineers available was assigned to the project. The story of the manufacture of nylon will be told next month.

Questions College Men ask about working with Du Pont

Where would I be located?

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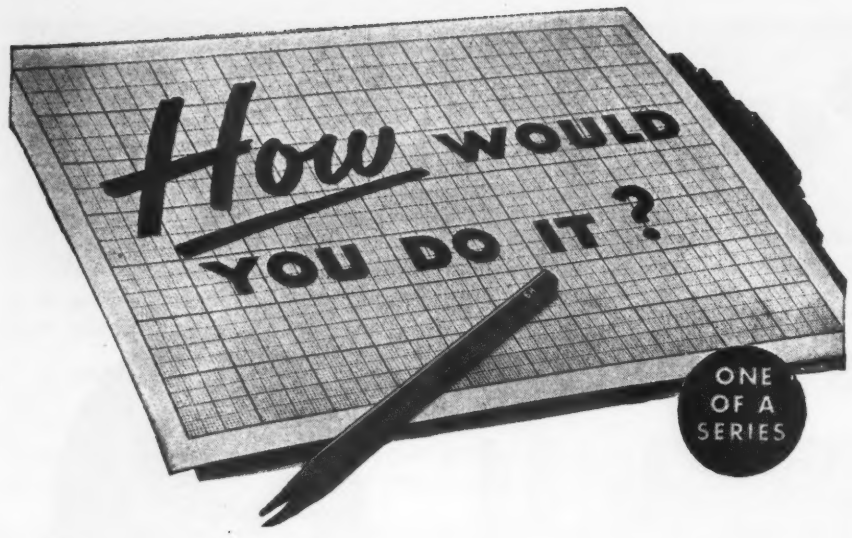

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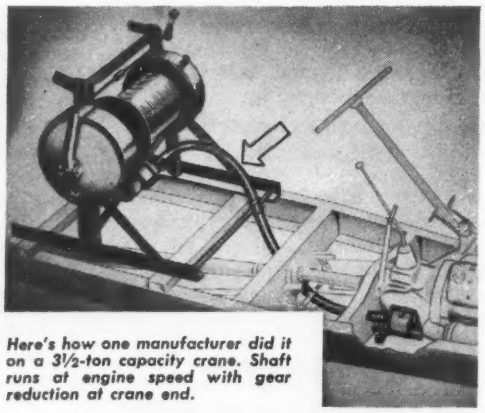
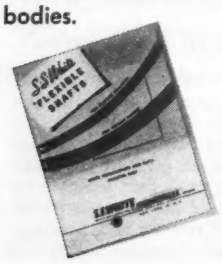


Here's how one manufacturer did it on a 3½-ton capacity crane. Shaft runs at engine speed with gear reduction at crane end.



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"... AND IN THE WAKE OF GIANTS ..."

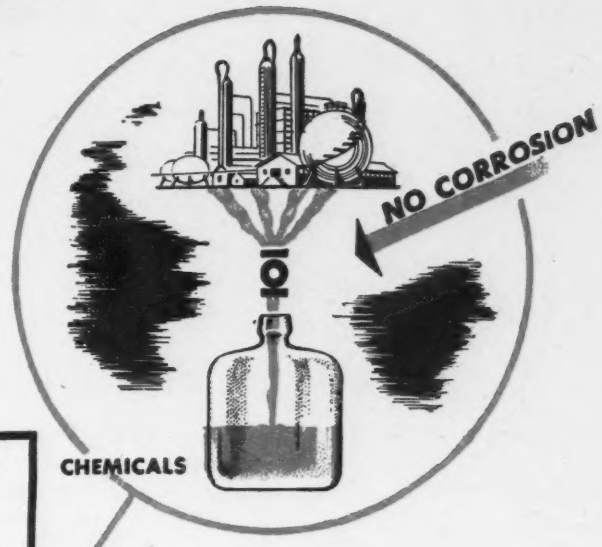
(*Continued from page 262*)

indicate that most meteors are truly the remains of disintegrated comets.

Meteors are invisible, being at a temperature close to the cold of space, and being too small to reflect sunlight. As soon as they enter the earth's atmosphere, they flare up with an incandescent heat of many thousands of degrees, caused by the sudden checking of their velocities of about twenty-six miles per second by the earth's atmosphere. They give off a brilliant white light for a few seconds, and then are pulverized to fine dust by heat and atmospheric friction. The heat intensity of meteors can best be appreciated when the light that they give off is compared to their average size, for *the average shooting star is smaller than the head of a pin.*

Occasionally an exceptionally large meteor will enter the atmosphere. If it weighs more than ten pounds, a portion of it may reach the ground as a meteorite. Once in many centuries, a meteorite weighing many tons will enter the atmosphere. A few of these are in captivity, the largest being a thirty-six-ton hunk of iron and stone, which resides in the Museum of Natural History, in New York City. Out in Arizona, there is a hole three fourths of a mile in diameter and six hundred feet deep. Around the edge of it there are vast quantities of meteoric stone, indicating that the crater was caused by the fall of a huge meteorite. Recently, a large one fell in Siberia, destroying by heat everything within a fifty-mile radius of it. The number of meteors entering the atmosphere daily has been estimated to be anywhere from twenty million to a billion, most of them being mere specks of dust, too small to be visible.

Finally, meteors have been found to contain about thirty elements, mostly consisting of nearly pure iron, nickel, and occluded hydrogen and helium. This is perhaps the most interesting feature of meteors, for if they are truly disintegrated comets, then they are messengers from outer space, where they have rubbed noses with stars, and are not inconceivably from other stars themselves. Thus they bring with them satisfactory proof that the flotsam of outer space, and the stars themselves, are similar in structure to our own earth.



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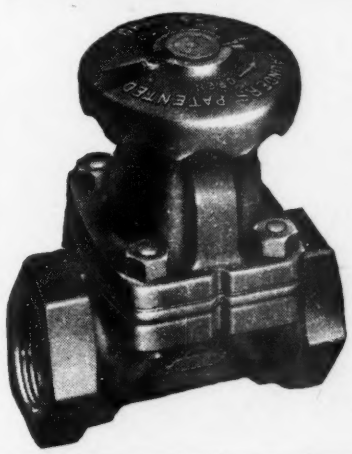
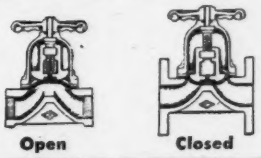
★ STREAMLINED FLOW

GRINNELL-SAUNDERS DIAPHRAGM VALVES



● The flexible diaphragm isolates the working parts of the valve from the fluid, preventing contamination, and permits streamlined flow plus positive closure even with suspended solids.

A selection of diaphragm materials and also body linings of glass, porcelain, lead, rubber or synthetics protects against corrosion.



A TYPICAL EXAMPLE OF GRINNELL PIPING SERVICE

COMPLETE . . . EVERYWHERE

Products Manufactured

● *Pipe and Tube Fittings* • *Engineered Pipe Hangers* • *Prefabricated Piping* • *Grinnell-Saunders Diaphragm Valves* • *Thermolier Unit Heaters* • *Job Work Casting* • *Automatic Sprinklers and other Fire Protection Systems* • *Amco Humidification and Cooling Systems* • *Other Piping Specialties*

Supplier of . . .

• *Pipe, Valves and Fittings* • *Specialties for Plumbing, Heating, Water Works and General Piping*

GRINNELL COMPANY, INC.
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GRINNELL

WHENEVER **PIPING** IS INVOLVED

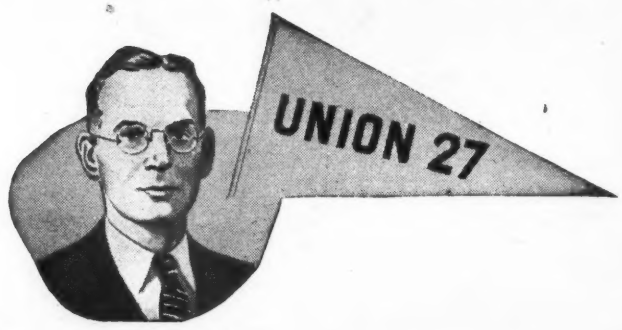
CORNELL UNIVERSITY
MAY 2 - 47

Campus to GENERAL ELECTRIC

TAX AUTHORITY

The Story of

DONALD MILLHAM



THE average man who stews over the filing of his annual tax return is apt to shake his head quizzically over Donald L. Millham.

While he was in charge of General Electric tax accounting, Don used to file more than 500 returns a year—and like it. In some years the sums he paid out in taxes exceeded the Company's net income by more than four times.

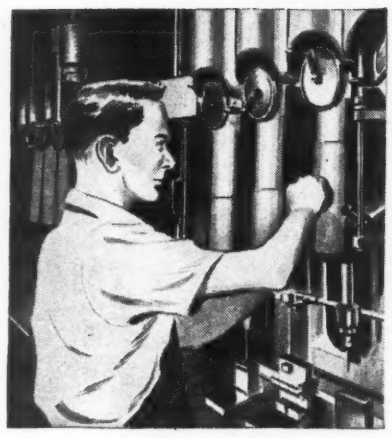
Although he has a new job today—the difficult and important one of Comptroller for the company—Don maintains an active interest in corporate taxation and is still considered one of the company's tax authorities.

A career in corporate taxation problems is, Don admits, short on glamor, long on hard and diligent work. In his early years with G.E. he had learned a great deal about business methods in the company's Business Training Courses, and had worked as an accountant and traveling auditor. But until 1935 he had little more to do with taxation than the filing of his own returns.

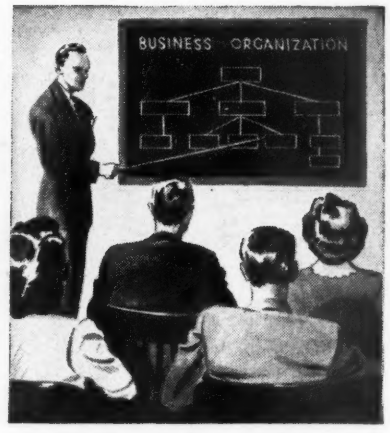
Then an opportunity opened in tax accounting. He took the offer and learned the background, the technical language, the legal complexities of his job as he did it.

By meeting the challenges of an exacting and constantly expanding field of endeavor, Donald Millham has made for himself a career with General Electric that is useful and important, and which has held his interest.

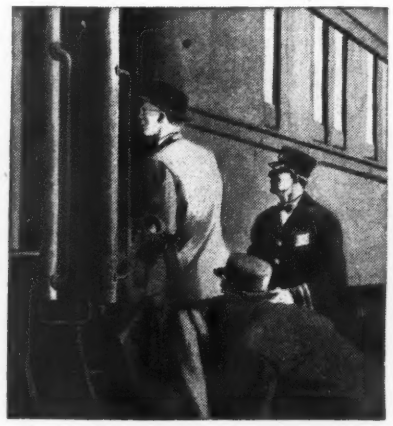
Next to schools and the U.S. Government, General Electric employs more college engineering graduates than any other organization.



To help pay his way through Union College, Don worked for General Electric during summer vacations, operating a drill press.



After graduating with honors, he enrolled in the G-E Business Training Course, gained insight into modern business operation.



For five years Don worked as a travelling auditor, made a good record. In 1935, without any prior experience in taxation, he took over General Electric tax accounting.

Learning the job as he worked at it, he became the company's tax authority, filing 500 returns a year. Today he has the difficult and important job of Comptroller.

GENERAL ELECTRIC

The Murray Printing Company
Cambridge, Massachusetts